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ZSU-23-4

SHILKA & SOVIET AIR DEFENSE GUN VEHICLES

Steven J. Zaloga

CONCORD
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603-609 Castle Peak Road
Kong Nam Industrial Building
10/F, B1, Tsuen Wan
New Territories, Hong Kong

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ISBN 962-361-039-4
Printed in Hong Kong

Front Cover

A ZSU-23-4M of the Lebanese Special Forces, captured from the Palestinians, leads a column of armored vehicles in southern Lebanon in 1989. Behind it is an American M113 APC, probably supplied from Israel, with an improvised mounting of a ZU-23 twin anti-aircraft gun. (Yves Debay)

Back Cover

A Shilka is loaded on board the pontoon of a GSP heavy amphibious ferry to be transported to the other side of the river. (Leonid Yakutin)

INTRODUCTION

This photo book deals with the Soviet ZSU-23-4 Shilka air defense gun vehicle, which has been built in larger numbers and seen more combat service than any other comparable vehicle. Also included in this book are the Soviet air defense gun vehicles which preceded the Shilka, and the vehicle which will eventually replace it, the Tunguska.

The Soviet Ground Forces have shown a great deal of interest in air defense vehicles due to their wartime experiences. It is common rule of thumb that armies which have been subjected to severe air attack usually show more appreciation for air defense than those that have not. So a result, the Soviets and Germans have generally paid greater attention to air defense than the British and American armies. The first Soviet air defense vehicle after the war was the ZSU-37. ZSU means zenitnaya samokhodnaya ustanovka, or mechanised anti-aircraft system. Work on the ZSU-37 had begun during World War 2, but very few were produced before the war ended. After the war, work on the ZSU-37 continued, as well as work on a version with 25mm guns. Neither was very successful as the turret traverse was too slow to keep up with modern ground attack aircraft. In the late 1940s, simple anti-aircraft vehicles were built on the BTR-40 and BTR-152 armored transporters. In both cases, a new ZTPU-2 turret was adapted to the rear troop compartment. These vehicles could be used against air or ground targets and they were built in small numbers. Quite surprisingly, some are still in service today. Similar adaption were tried on other chassis, including an anti-aircraft version of the BTR-50.

The first major attempt to develop an air defense vehicle to support mechanised formations was the ZSU-57-2, which first entered service in the early 1950s. This effort combined the highly successful S-60 57mm anti-aircraft gun with the equally successful T-54 tank chassis. Unfortunately, the resulting combination was not as successful. Although the ZSU-57-2 had formidable firepower, its lack of a fire direction radar meant that it had very low probabilities of hitting fast new jet attack aircraft. It was first used in combat in the 1967 Mid East war by the Egyptian Army. It was almost entirely ineffective against low-flying jet strike aircraft. Lacking radar, it could not detect aircraft early enough to orient its gun system, and once the jets did become visible, there was not enough time to accurately lay and aim the guns.

These problems were appreciated even before the ZSU-57-2's combat debut. In 1958, the Nikolai Astrov Design Bureau was given the assignment of developing a new generation air defense gun vehicle using radar fire control, codenamed izdeliye 6129 Shilka. Shilka is the Russian word for a small pointed tool, the awl.

The early experiments with a radar-directed, vehicle-mounted gun proved frustrating. The designers wanted to mount the radar low to reduce the problem with parallax between the axis of the guns and the axis of the radar. Radars mounted between the guns placed the guns so far out on the turret race that when they fired they upset the stability of the turret. An effort to mount the guns centrally with the radar off-set to one side had equally dire consequences when the muzzle blast shattered the radar antenna. In the end, the designers decided to mount the radar on top of the turret. This created parallax problems with the guns, but these could be solved using simple ballistic computers. The gun system was mounted in the center of the turret. Consideration was given to both 37mm and 57mm guns; however both types were clip fed and so could not match the rate of fire that was desired. The gun selected was a modified version of ZAP-23, used on the ZU-23 towed anti-aircraft gun mount. The ZAP-23 was air-cooled, the new vehicle gun, the AZP-23, was liquid cooled for a higher rate of fire. The chassis selected for the new vehicle was the ASU-85 tank destroyer, also designed by Astrov's bureau. This proved too light to support the 8 ton weight of the new turret and its associated equipment. As a result, a new hull design was developed using PT-76 components, called the GM-575. The Soviet Army was still interested in adapting the turret to an existing hull type. So the new turret was mounted on a modified T-54 hull with a spacer added to accommodate the wider turret race. This solution proved no more acceptable since there wasn't enough internal hull volume to mount the DT-4 auxiliary power unit needed to supply electricity to the turret systems when the main engine was turned off. The fire control for the guns was provided by the RPK-2 (NATO: Gun Dish) radar, also known as the 1RL33.

The first prototypes of the Shilka were completed in 1961 and it was formally accepted for service use in 1962. However, series production was delayed until 1965 due to a variety of problems. One of the main sources of trouble was the vehicle's complex electronics. At this point in time, the Soviet Union was behind the United States, Japan and Europe in solid-state technology. As a result, most of the electronic systems onboard the Shilka used vacuum tubes rather than transistors or other solid state devices. These tubes had far lower reliability than solid-state devices, and the vibration, dust and heat conditions of armored vehicles in the field further degraded the performance of the electronics. Nor was the early Shilka appreciated by its crews. There were three men located in the turret: the vehicle commander, gunner and range-finder. While the turret seems large from outside, its interior is filled with the gun system and ammunition up front, and the radar's electronics in the rear. When the vehicle had the radar turned on, the vacuum tubes and other electronic components soon warmed up and made the turret interior unbearably hot. As will be evident in photos of the early vehicles in this book, the designers were forced to continually rework the configuration of the turret venting in an attempt to reduce the heat build-up problems. This problem was not unique to the Shilka. The US Army's Mauler missile program was similarly disrupted by the problem of trying to pack large quantities of electronics in a small vehicle chassis, and the Mauler was finally cancelled.

The Shilka went through five major variants during its production. There were two early series variants which were very similar externally. Neither of these types was produced in large numbers. The ZSU-23-4V Model 1968 Shilka was the first version to be manufactured in significant numbers. It was first seen at the 1968 Moscow parade. It was not exported in large numbers, although a few were sold to Poland. The fourth major variant, the ZSU-23-4V1 was the first version to be widely exported, and the first version to be license manufactured outside the USSR, in Poland. It was numerically the most important member of the Shilka family, having been manufactured from the early 1970s through the early 1980s. This version had major improvements in vehicle electronics and reliability, and can be distinguished externally by the large bulged panniers on the turret side which were more streamlined than on the earlier vehicles. It used the 1RL33M2 version of the RPK-2 Gun Dish radar. The fifth and final version of the ZSU-23-4 family was a major redesign of the electronics system which incorporated a larger portion of solid-state electronics as well as new features in gun fire control. In fact the modernization effort was so extensive that it was originally panned to rename the vehicle Biryuza (Turqoise). Even after it entered service, the new ZSU-23-4M version was

still called Shilka by its crews, so the Soviet Ministry of Defense eventually gave up trying to called it Biryuza. This version entered production in the mid 1970s and was first seen around 1977. It has been exported to many countries, though not as widely as the ZSU-23-4V1. In total, some 23 countries use the Shilka in its various models. About 6,500 were built, of which about 2,000 were exported. By way of comparison, only 582 Gepards were manufactured.

The first combat use of the Shilka took place in October 1973 during the Yom Kippur War. It earned a reputation as a very lethal weapon system in this war. Part of the reason for its early success was its novelty. Israeli jet pilots had come to fear the Soviet S-75 (SA-2 Guideline) and S-125 (SA-3 Goa) air defense missiles, and concentrated their attention on avoiding these weapons. One of the best tactics against the Soviet missiles was to fly low where they performed very poorly. However, low altitude tactics meant that the Israeli aircraft ran into the Shilka instead. It has been credited with at least 31 of the 103 Israeli aircraft losses (possibly more due to uncredited losses). Soviet sources claim that it was deployed to Vietnam during the war with the United States, but there is little evidence it saw any combat. The Shilka was subsequently used in a number of wars around the globe. It was used by both Iraq and Iran in the 1980s Gulf War, by Iraq in the 1991 Desert Storm Gulf War and in a number of smaller conflicts. In the 1991 Gulf War, it proved largely ineffective. By the 1990s, the US had already developed countermeasures to degrade its performance.

During the Afghanistan War, the Shilka was a popular vehicle for convoy escort duty. Its four 23mm cannon could lay down a fearsome barrage, and its high angle elevation allowed it to be used against mujihadeen high on neighboring slopes who had earlier proved invulnerable to tank guns of other low elevation weapons. The Shilkas were equally popular with Soviet troops when operating in built up towns, since the 23mm fire could easily devastate the clay walls of the duvals. By the final years of the war, a local modification was developed, removing the RPK-2 radar and its electronics and using the additional space inside the turret to double ammunition stowage from 2000 to 4000 rounds. In Afghanistan, the Shilka was nicknamed Shajtan-Arba: the Devil's Chariot, by the mujihadeen.

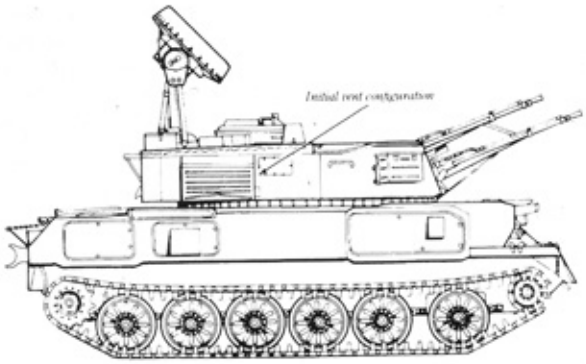
Development of a replacement for the Shilka was begun in the late 1970s by the Fasotron NPO under the codename Tunguska. In Soviet Army service, the Shilka had served alongside 9P31M Strela 1 missile vehicles (SA-9 Gaskin) with a platoon of four Shilka and a platoon of four 9P31Ms forming an air defense battery in each motor rifle and tank regiment. One of the aims of the Tunguska program was to consolidate these features in a single vehicle. The Soviets still desired a gun vehicle, since guns are generally more effective against very low flying helicopters and aircraft which can be easily lost to radar due to ground clutter. On the other hand, missile have greater lethality against aircraft at ranges outside the effective range of the cannon. The resulting vehicle was designated 2S6 Tunguska, although it is also designated 2K22 which covers both the gun and missile system. The Tunguska is much heavier than the Shilka and is mounted on a new GM-569 armored vehicle chassis related to the 9A39 Buk (SA-11 Gadfly) and Tor (SA-15) air defense missile vehicles. The Tunguska entered service in the late 1980s with the Soviet Army. It was exported to East Germany in 1989, but the vehicles were withdrawn back to the USSR when Germany was reunited. Exports to other countries including India had been concluded by the time this book was written in 1992.

The author would like to acknowledge the help of many friends in the preparation of this book, including James Loop, Stephen Sewell, Russ Vaughan, Janusz Magnuski, Michael Jerchel and Christopher Foss. Thanks also go to the staff of the 24th Infantry Division Museum at Ft. Stewart, Georgia for their kind help while I was photographing the Iraqi Shilka preserved there. As a technical note, modelers should be aware of the fact that many of the interior photos of the Shilka here were taken with a 16mm fish-eye lens which tends to distort shapes the further away they are from the center of the picture. Nevertheless, such lenses are the only way to take comprehensive photographs of armored vehicle interiors, especially those as cramped as the Shilka!

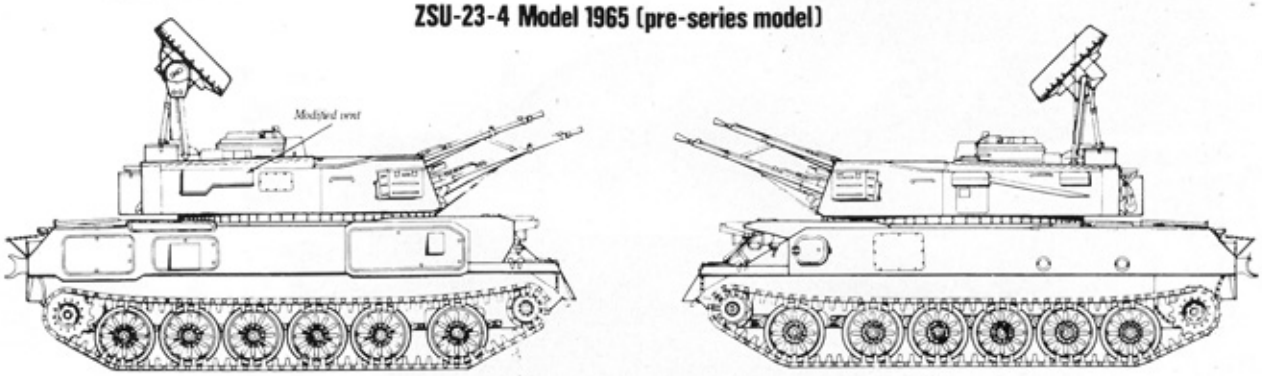
Comparative technical data

Designation	ZSU-57-2	ZSU-23-4	2S6
Soviet Codename		Shilka	Tunguska
Crew	6	4	4
Weight (metric tons)	28.1	20.5	34
Length (m)	8.48	6.69	7.84
Width (m)	3.27	3.08	3.47
Height (m; w/radar erected)	2.75	2.63	3.89
Gun Type	S-68	AZP-23	
Gun caliber(mm)	57	23	30
Number of guns	2	4	4
Ammunition (no. of rounds)	316	2000	1904
Max. effective gun range (optical; km)	4	2	2.5
Max. effective gun range (radar; km)	-	3	4
Max. missile range	-	-	8
Reaction time (sec)	5	7	8
Initial gun muzzle vel. (m/s)	1000	930	1200
Radar range (km)	-	20	18
Chassis	T-54 mod	GM-575	GM-569
Engine	V-54	V-6R	V-59
Horsepower	520	280	520
Max. speed (km/h)	50	44	65

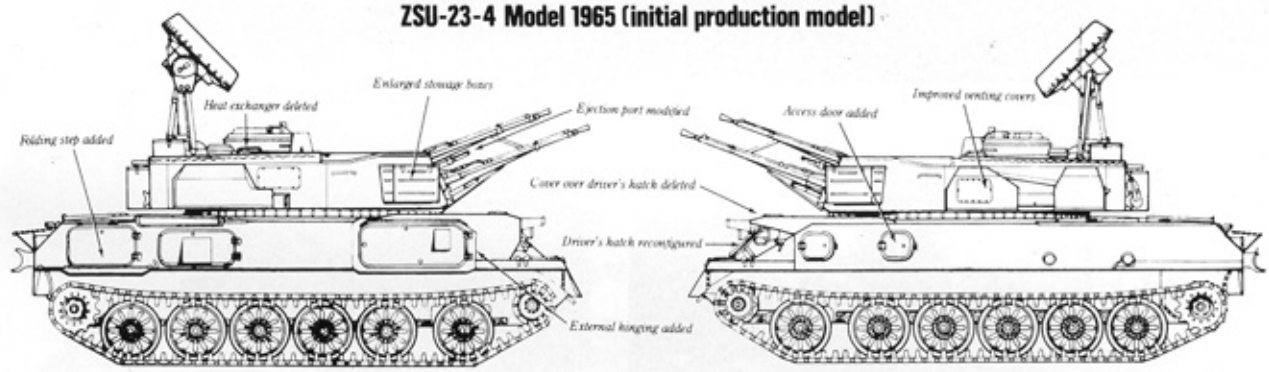
Evolution of the ZSU-23-4 Shilka



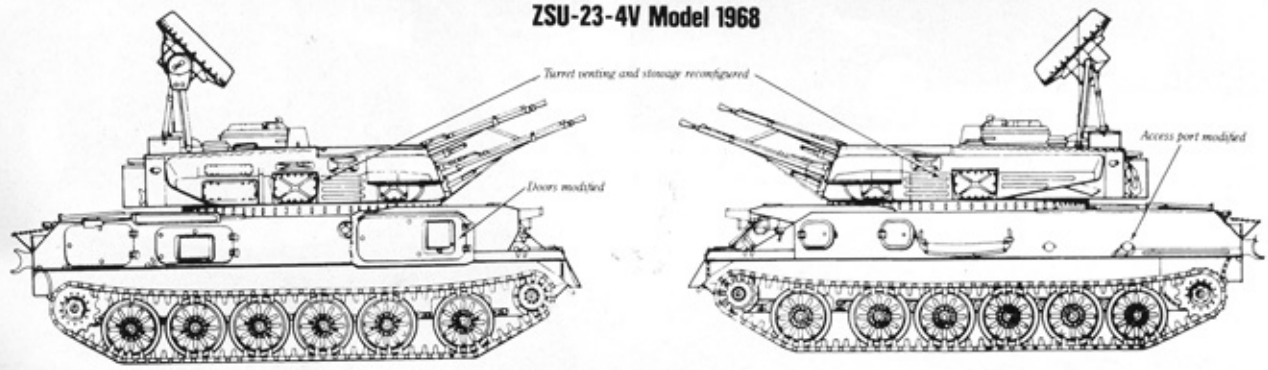
ZSU-23-4 Model 1965 (pre-series model)



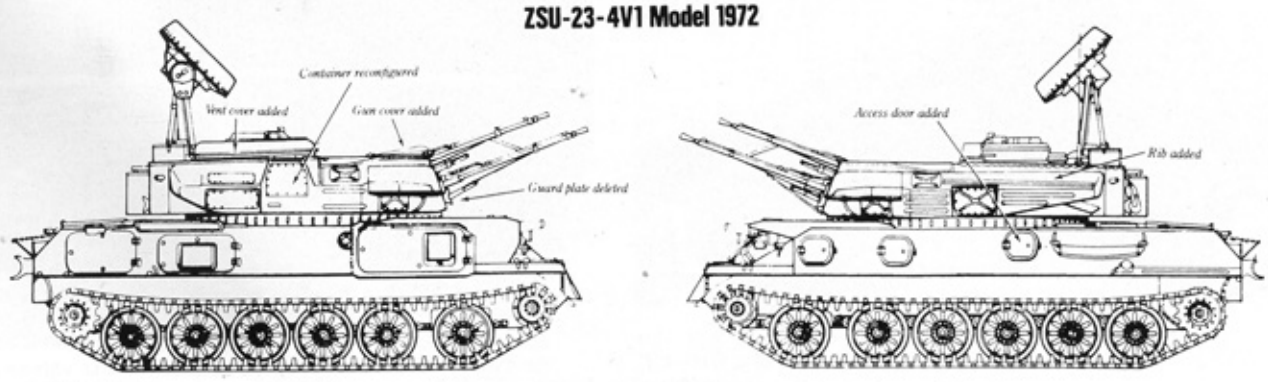
ZSU-23-4 Model 1965 (initial production model)



ZSU-23-4V Model 1968



ZSU-23-4V1 Model 1972



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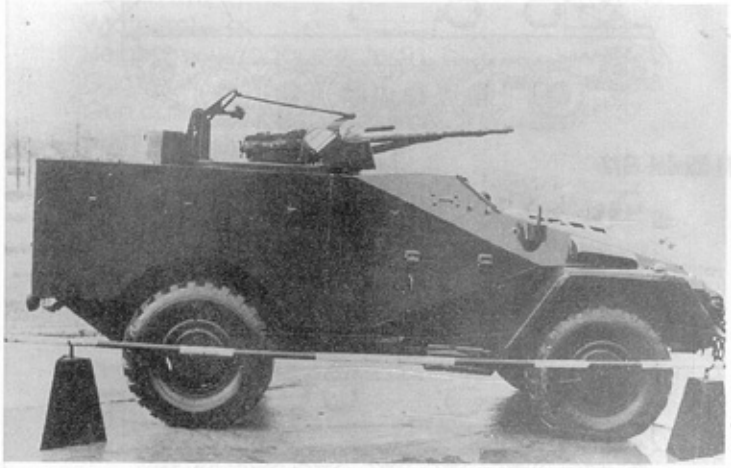
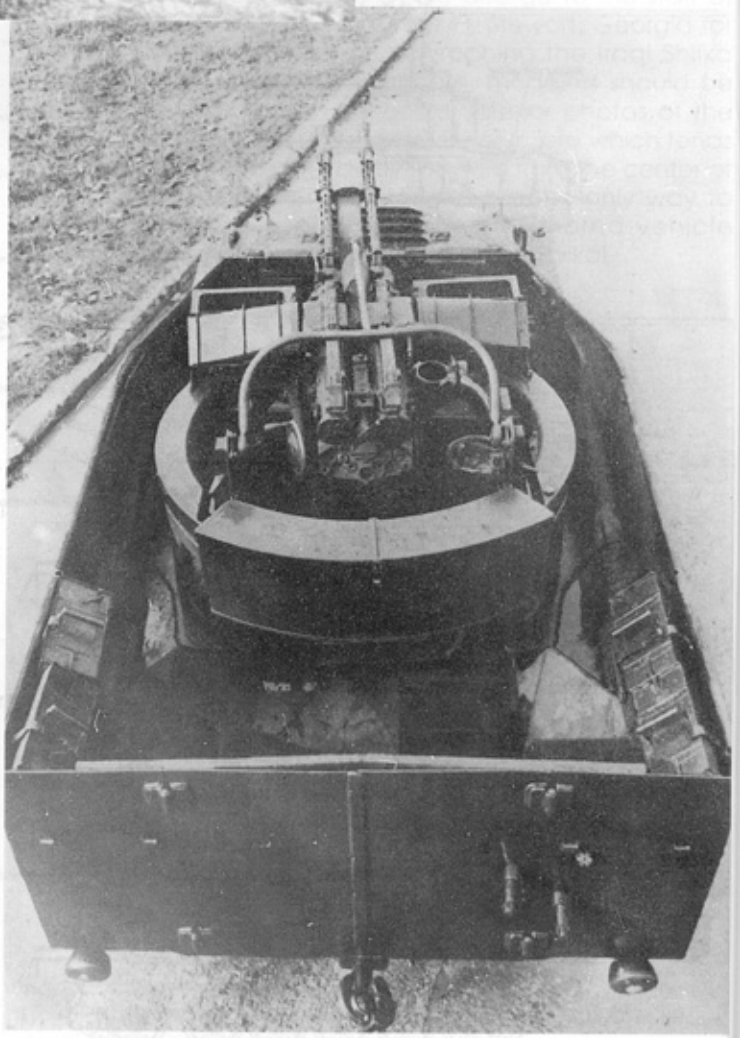
ZSU-23-4M Model 1977

The ZSU-37 was the first air defense gun vehicle in Soviet service after World War 2. It had too slow a rate of turret traverse and was never built in significant numbers. It was based on the same chassis as the more successful Su-76 Suka self-propelled gun.

In the late 1940s, the BTR-40A fire support vehicle was developed on the basis of the BTR-40 armored transporter. These vehicles were intended to be used against both air and ground targets.

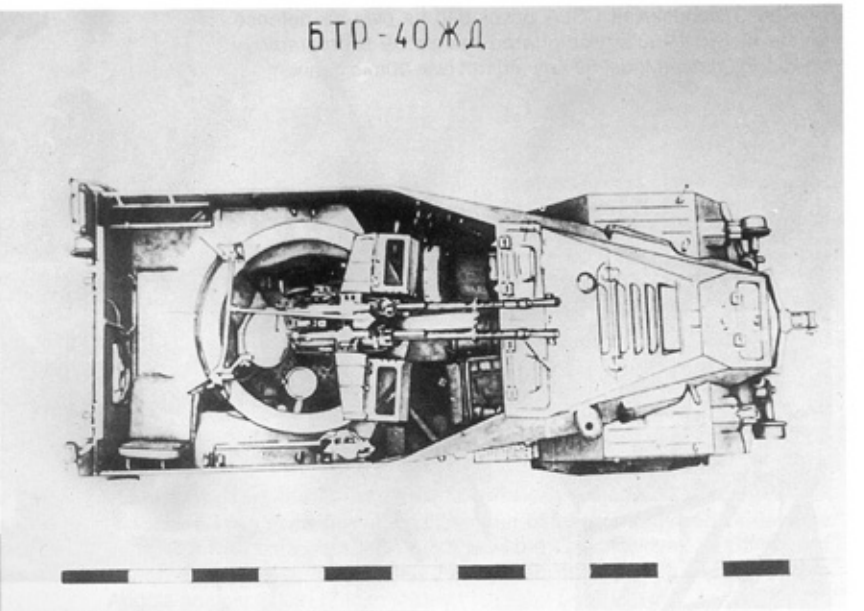


This BTR-40A fire support vehicle was still in service with the Romanian ASR in the early 1990s. The BTR-40A consisted of a BTR-40B chassis with the ZTPU-2 anti-aircraft mounting with twin 14.5mm Vladimirov heavy machine guns.



An overhead view of a Romanian BTR-40A. This vehicle carried 1200 rounds of ammunition, partly in the ready cassettes on either side of the guns, and the remainder in the rear turret bin and in the hull.

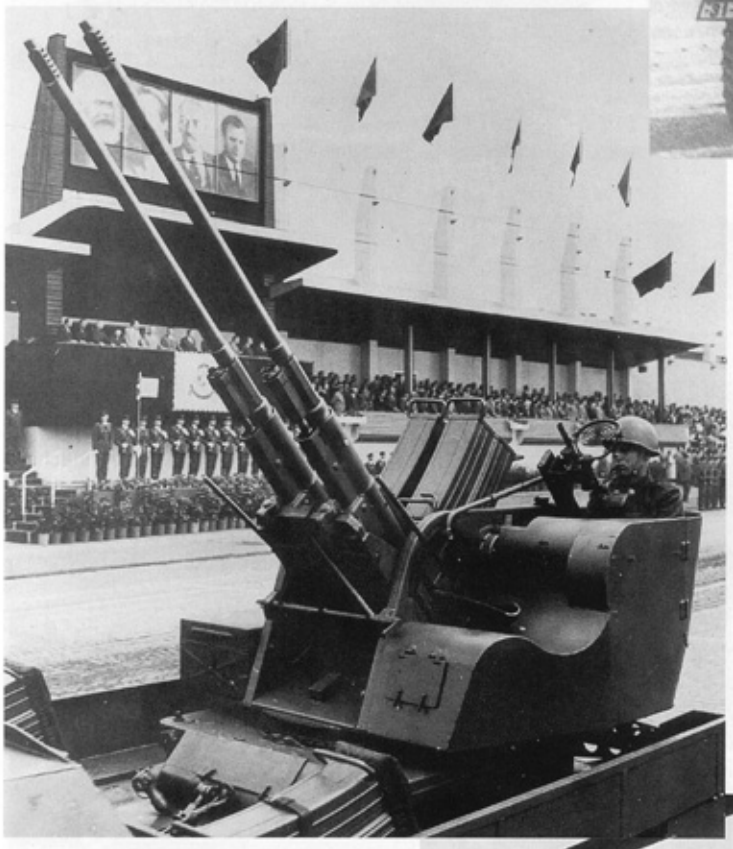
The last version of the BTR-40 in service with the Soviet Army is the BTR-40ZhD. This is a BTR-40A with railroad adaptors on the front and rear to allow the vehicle to travel along rail lines. These vehicles were still in Soviet Army service in the early 1990s to provide air defense cover for railroad units and to patrol rail lines.



The BTR-152A was an equivalent of the BTR-40, but mounted on the BTR-152 chassis. It used the same ZTPU-2 twin 14.5mm heavy machine gun mounting. In later years, some BTR-152 were fitted with the quad ZTPU-4 mounting, but this version was not widely produced.

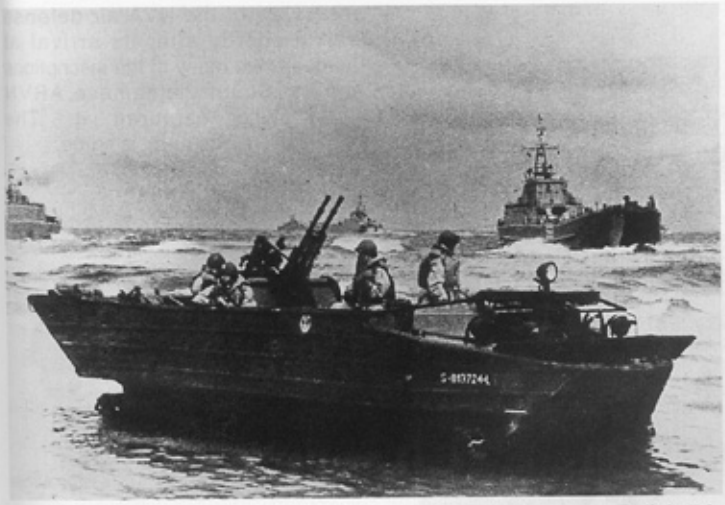
The BTR-152 was widely exported around the world, including to the Palestine Liberation Organization. This PLO BTR-152 was modified by the addition of a ZU-23 23mm anti-aircraft gun mount. It was used mainly for attacking ground targets or helicopters. This particular vehicle was captured by Israeli forces in the 1982 Lebanon war.

The Czechoslovak CSLA developed its own air defense vehicle in the 1950's, designated the *vz.59 protiletadlovy dvojkanon 30mm* (Model 59 anti-aircraft twin 30mm cannon).



A close-up of the vz.53/59 twin 30mm gun system on the vz.59 vehicle.

A vz.59 system being loaded into a Mi-6 helicopter during Warsaw Pact exercises.



To provide air cover during amphibious operations, the Polish 7th Lusatian Naval Assault Division mounted ZPU-2 anti-aircraft mounts on K-61 (GPT) amphibious transporters. The ZPU-2 is a twin mounting for the KPV 14.5mm heavy machine gun.

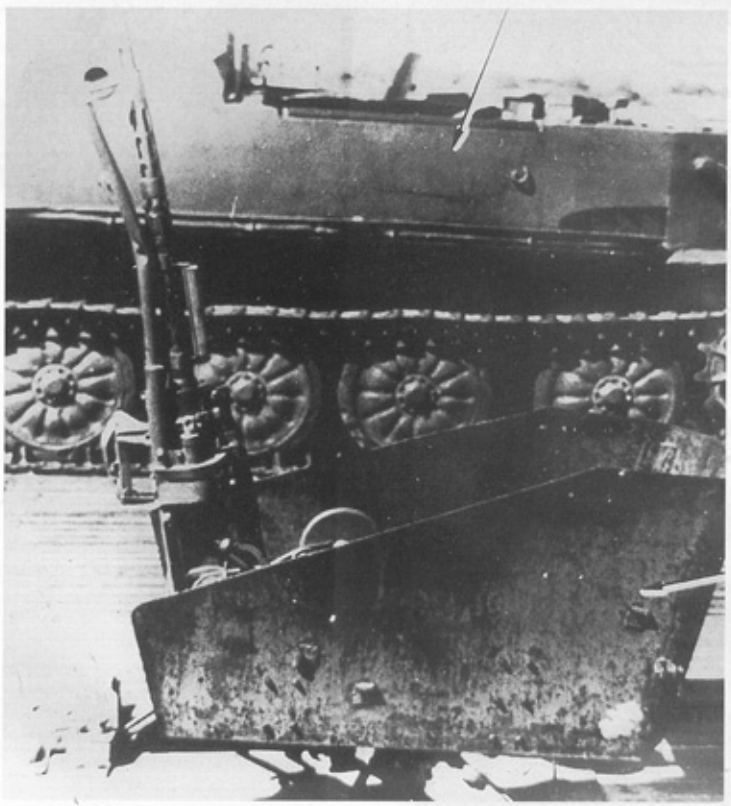
The Cuban Army built a small number of these improvised air defense vehicles which consist of a BTR-60PB with a Czechoslovak Vz.53/59 twin 30mm autocannon. These may have been used during the fighting in Angola against South African forces.

During the Vietnam War, the North Vietnamese Army was provided with small number of ZSU-57-2 air defense vehicles. To supplement these, small numbers of T-34-85 tanks were modified with a new turret mounting the Chinese Type 63 twin 37mm gun. This vehicle is currently preserved at the US Army Ordnance Museum at Aberdeen Proving Ground.

Another view of the NVA Type 63 air defense vehicle. The large container on the side was used to carry additional ammunition.

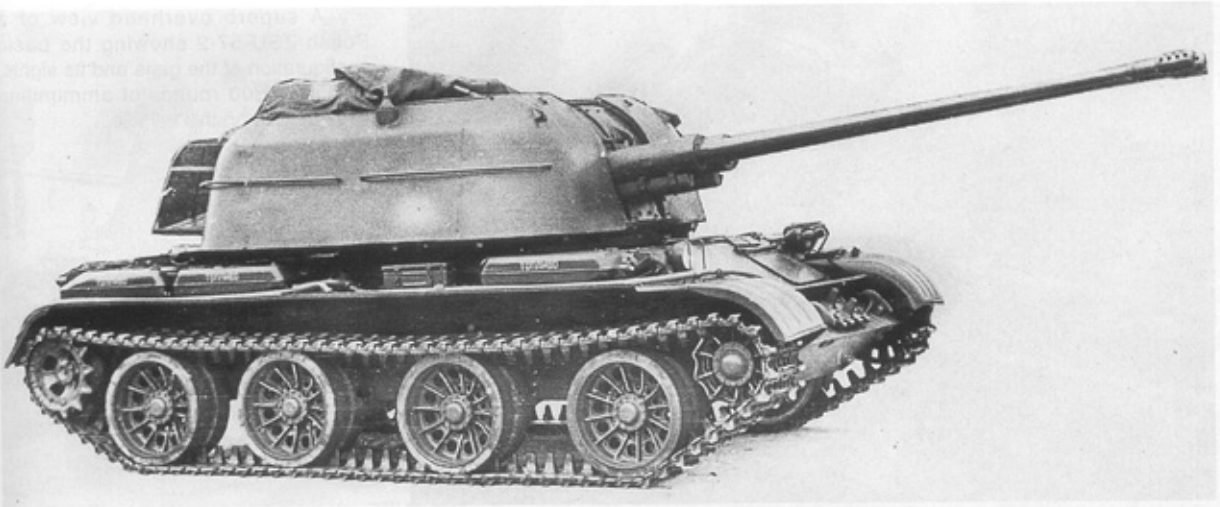
A view of the NVA air defense vehicle shortly after its arrival at Aberdeen with many of the inscriptions from the South Vietnamese ARVN troops who captured it. The construction of the turret is crude.

Several Warsaw Pact armies developed simple air defense vehicles for airfield protection. This East German NVA W-50 truck mounts a 2M3 110PM twin 25mm naval air defense gun turret, probably surplus from a German coastal patrol vessel.



To further supplement the air defense protection of mechanized formations, some of the BTR-50s used by the North Vietnamese in the war in South Vietnam had an improvised turret added on the rear deck. This consisted of a standard Soviet ZPU-1 single 14.5mm KPV heavy machine gun mounting with a simple armored shield built around it. In this view, it is on the ground. It was simply placed on the rear deck of the BTR-50P, and could be removed if necessary.

During the Afghan war, Soviet transport battalions mounted standard anti-aircraft guns to trucks to provide road security during convoys. This ZiL-130 is equipped with a ZPU-2 twin 14.5mm KPV heavy machine gun mounting.

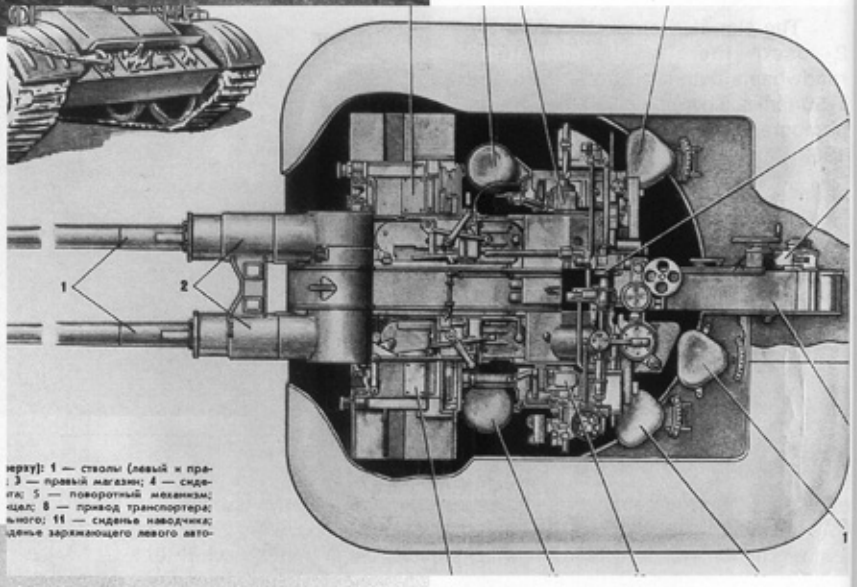


The first major air defense vehicle of the post-war years was the ZSU-57-2. This vehicle consisted of a modified and lightened T-54 tank hull with a new turret armed with the S-68A twin 57mm guns. This is an early production vehicle with the skeleton pattern roadwheels.

The standard production ZSU-57-2 used the "starfish" pattern roadwheels common to the T-54 and T-55 tanks. This particular vehicle was photographed at a parade in Berlin in 1962.

A pair of East German NVA ZSU-57-2 vehicles on parade in Berlin in the 1960s. This vehicle was a mechanized equivalent of the S-60 towed 57mm gun, one of the most common Soviet air defense guns of the post-war period.

A superb overhead view of a Polish ZSU-57-2 showing the basic configuration of the guns and its sights. A total of 300 rounds of ammunition were carried on this vehicle.



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An illustration from a Soviet publication showing the configuration of the turret interior.

A ZSU-57-2 of the Polish 7th Lusatian Naval Assault Division with its distinctive pale-blue insignia on the turret front. The ZSU-57-2 served in air defense platoons in tank regiments, each Soviet regiment having 4 of these vehicles.

The Finnish Army purchased the ZSU-57-2, and kept them in service well into the 1980s, long after they had been retired in Warsaw Pact armies. The large rear bin is used to catch spent shell casings.

A rear view of a Finnish ZSU-57-2 in service in 1975 with a cartoon plaque on the rear turret bin. (Kalevi Moilanen)

A side-view of a Finnish ZSU-57-2 showing the major difference from the T-54 tank chassis - only four roadwheels. The ZSU-57-2 used much thinner armor than the T-54 tank, so did not require as much support as the basic tank suspension. (Kalevi Moilanen)

A ZSU-57-2 of the Finnish Army in the three-color camouflage pattern.

One of the lesser known clients of the ZSU-57-2 was the Imperial Iranian Army. During the Shah's reign in the 1970s, Iran swapped oil for armaments with the Soviet Union. These ZSU-57-2 were later used in the war with Iraq in the 1980s.

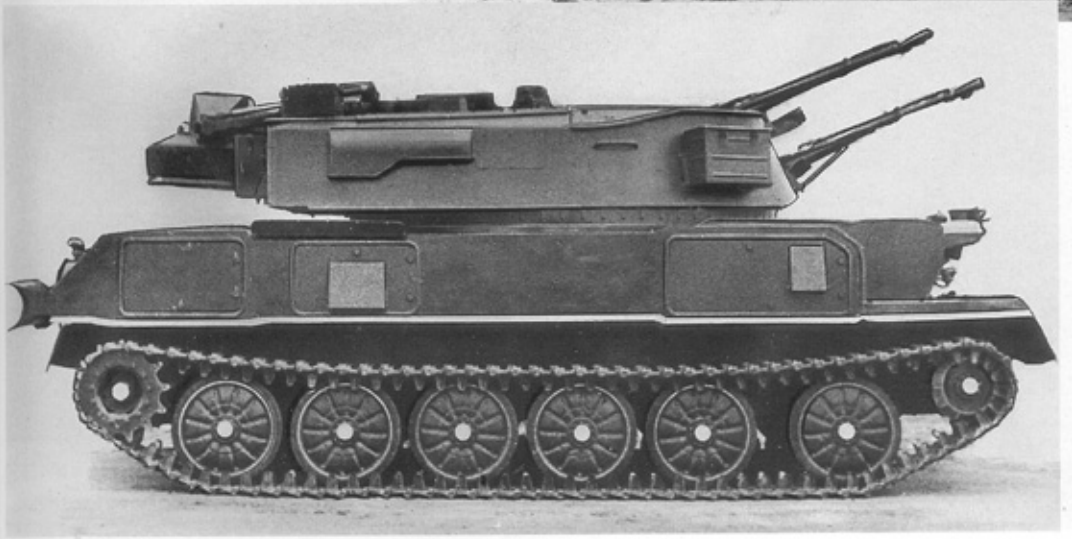
A North Vietnamese ZSU-57-2 knocked out during the fighting in South Vietnam. The North Vietnamese paid considerable attention to air defense of their tank units due to the threat posed by American aircraft. Soviet sources claim that the ZSU-23-4 Shilka was also used by the NVA during the war, though there is no photographic evidence.

The People's Republic of China built a copy of the ZSU-57-2 on the Type 69 hull as the Type 80. It can be distinguished from the Soviet version by the characteristic Chinese saw-tooth track skirts.

In the late 1980s, the PRC developed a successor to the ZSU-57-2, mounting twin 37mm guns, but fitted in a fully enclosed turret and directed by radar fire controls.

The first radar-directed air defense gun vehicle to enter Soviet service was the ZSU-23-4 Shilka (Awl). Pre-production vehicles like this one were deployed with operational trials units around 1964. The early version can be distinguished by the short air vent ducts on the left side of the turret. Note also how large the front driver's door of the ZSU-23-4 pre-production model is compared to later versions.

A very early production ZSU-23-4 in Polish LWP service. This version has a very small cooling vent cover on the right turret side compared to later vehicles.



Another side view of the initial production version of the ZSU-23-4. In this view, the RPK-2 (Gun Dish) radar is folded down over the turret rear in travel position.

The first common production version of the ZSU-23-4 Model 196 had many small changes from the pre series type. On the left turret side, the cooling ducts have been extended from the edge of the roof, all the way down the sides.

A ZSU-23-4 Model 1965 on parade in Moscow. Notice that the cooling vent cover on the right turret side has been extended down compared to the pre-series Model 1964 version.

An interesting overhead view of the ZSU-23-4 Model 1965. This vie shows the enlarged cooling vent cover towards the rear of the turret sides Another difference between the early Shilkas and the more common type is the configuration of the driver's station and driver's hatch.

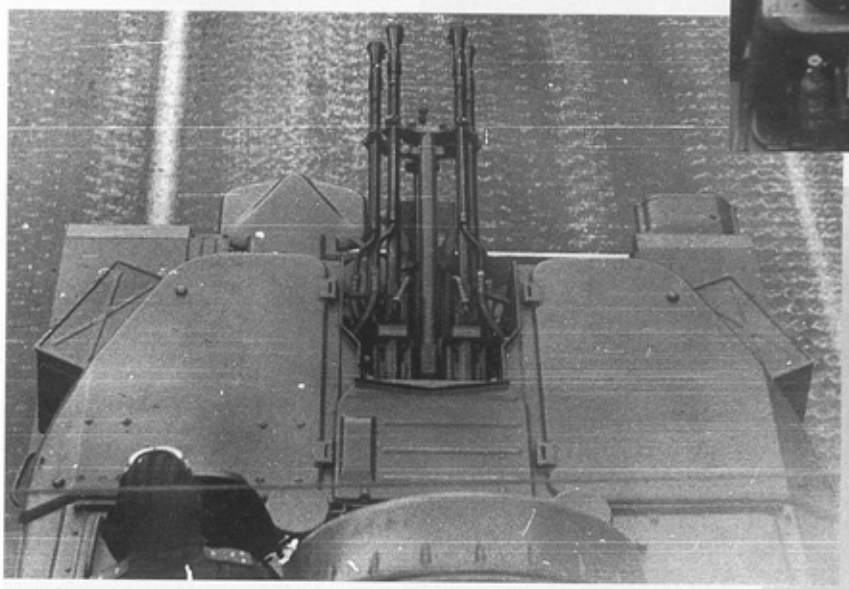
The most common version of the early Shilka was the ZSU-23-4V Model 1968. This version has a considerably enlarged cooling vent cover on the left turret side, evident in this view. The many changes in these covers was due to problems of heat build-up in the tube-electronics inside the Shilka turret. This vehicle is currently preserved at the Soviet Army Artillery Museum in St. Petersburg (Leningrad).

A view of the ZSU-23-4V Model 1968 during its first public display in Moscow in 1968. The enlarged cooling vent covers of this version are very evident in this view. One of the changes introduced on this model was the armored cover over the driver's front hatch window.

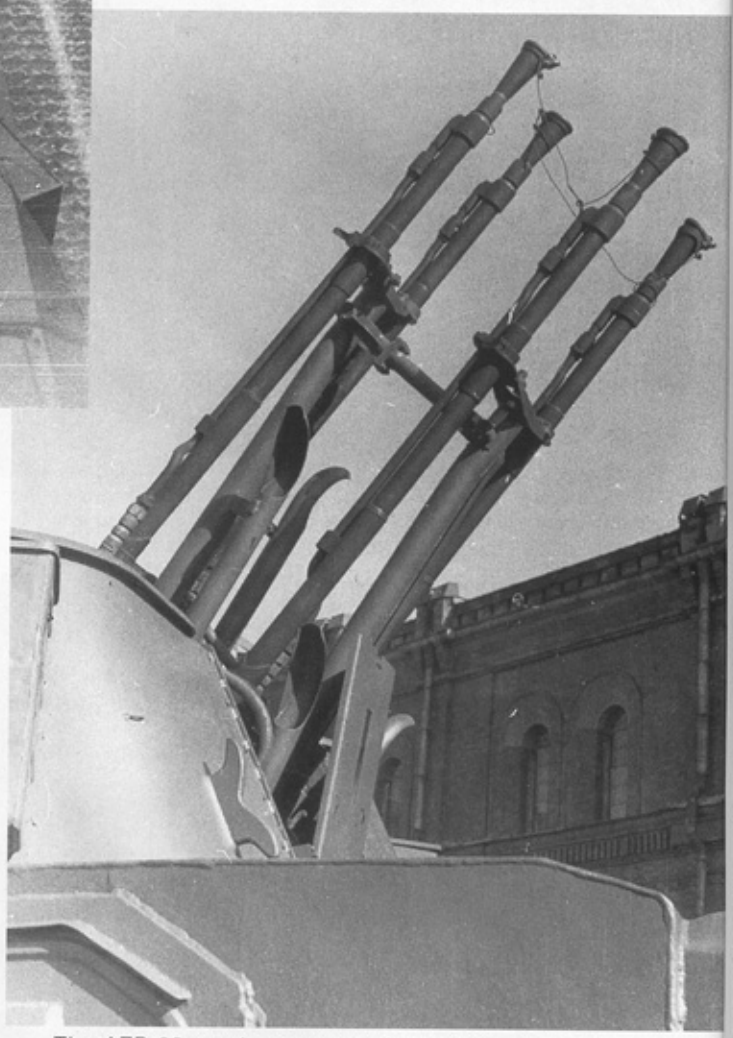
Another view of the ZSU-23-4V preserved at the St. Petersburg Artillery Museum. The particular angle of the radar dish on the turret rear suggests that it has been disconnected; this would not occur on a vehicle in service.

A head-on view of the ZSU-23-4V Shilka. This particular version of the Shilka was not widely exported.

An overhead view of a ZSU-23-4V Model 1968 showing the configuration of the turret stowage. The oval devices on the turret roof are heat exchangers used to cool the internal electronics in the vehicle.



A close-up of the quad AZP-23 23mm cannons located in the forward turret compartment.

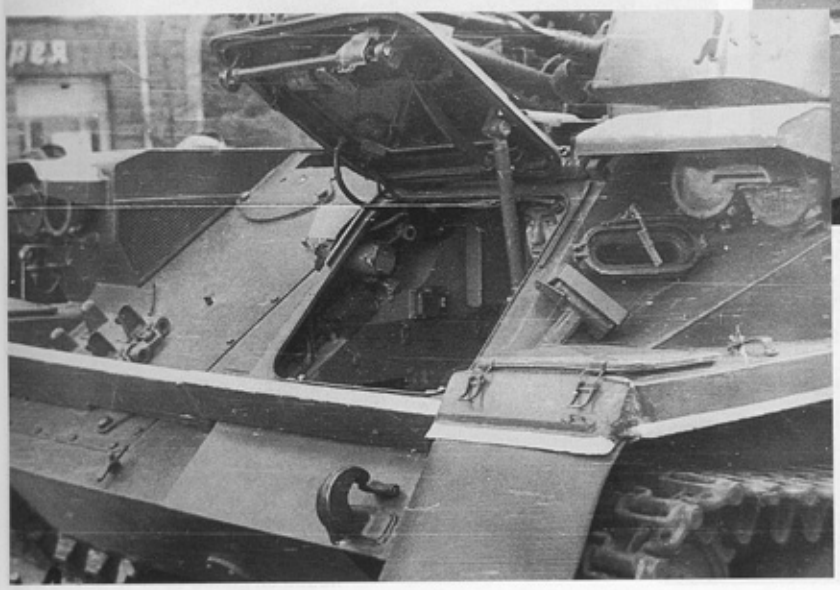


The AZP-23 quad cannons at full elevation. The curved tubes undereach set of guns are shell ejector ports which spit-out the spent ammunition casings after firing. Notice that each of the gun tubes have small caps over the barrel opening. This prevents rain from entering the barrel. Immediately before firing, these caps are swung open by means of a small set of wires that leads back into the gun mechanism.

Close-up of the AZP-23 guns on a ZSU-23-4V Model 1968 Shilka. The tubes above each gun barrel are for water cooling the gun jackets.

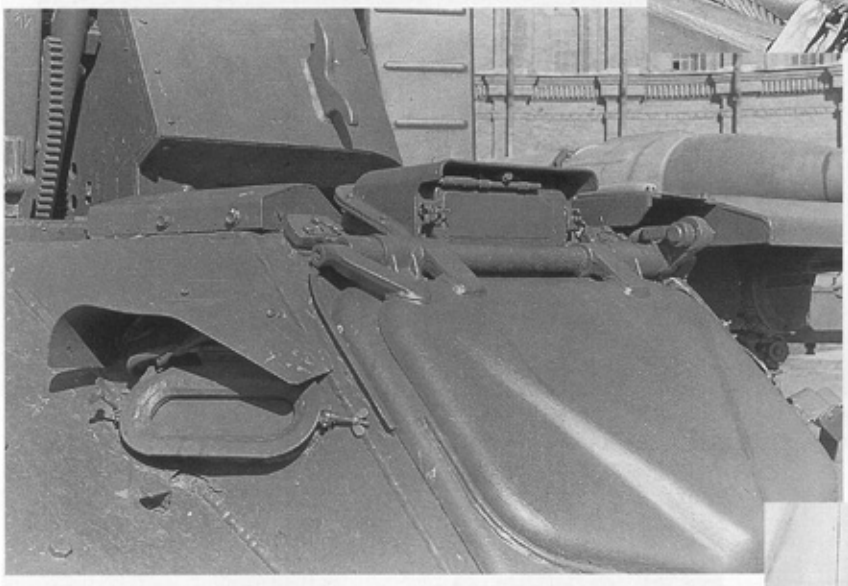
A front view of a ZSU-23-4V Model 1968 on parade in Moscow. The white trim on the vehicle was common only during parades, not during troop use of the vehicle. Notice how the driver's compartment has a small armored cover over the front windshield.

Another front view of a ZSU-23-4V Model 1968. In this view, the driver's door is completely open. The door on the -V version is shorter than on the earlier Model 1965. On the ZSU-23-4 Model 1965, the door extended below the water splash bar.



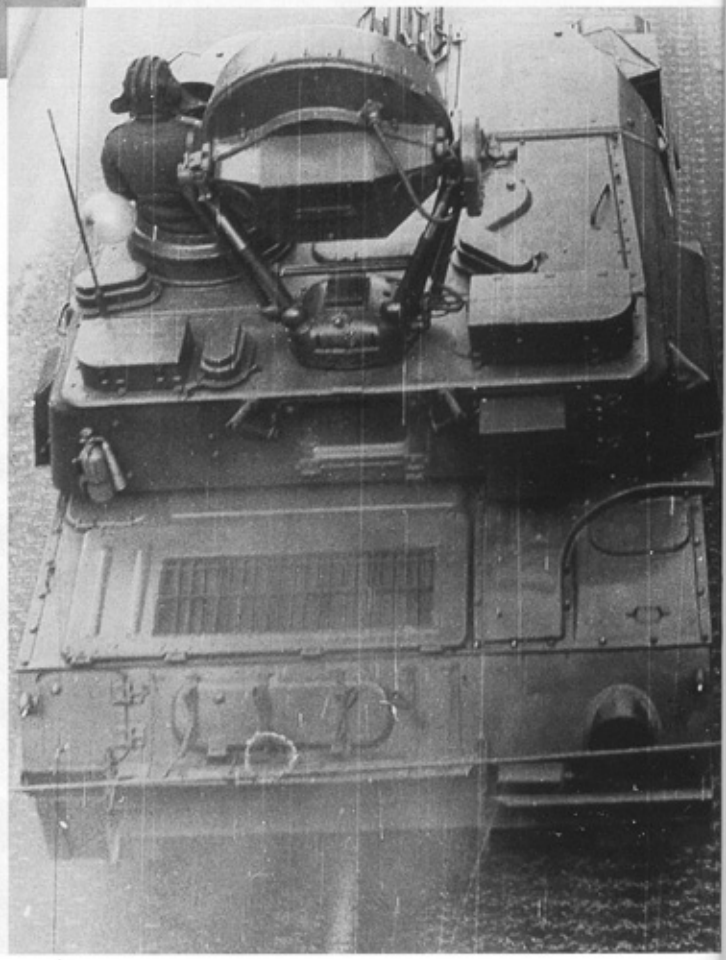
A view of the driver's station from the opposite side showing interior details. Just below the left driver's port is a storage clip for a mallet.

A close-up of the driver's station of the ZSU-23-4V at St. Petersburg. Notice that the driver's viewing port is missing its wiper, and that the mallet is missing from the stowage rack. This view shows the location of the day/night driving lights under the armored hood.



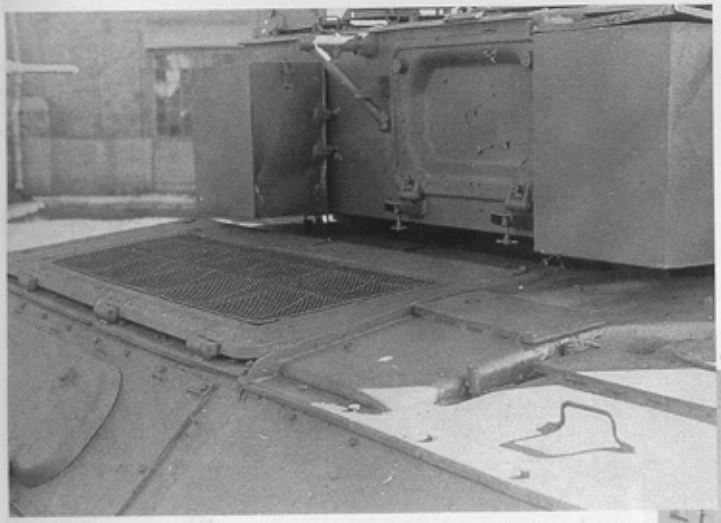
A close-up of the driver's station from the opposite side showing the periscope above the main door.

A rare view of a unit of Polish ZSU-23-4V Model 1968 on parade in Warsaw. These early versions of the Shilka were exported in very small numbers, most Warsaw Pact armies receiving the later ZSU-23-4V1.



An overhead shot of a ZSU-23-4V Model 1968. The main changes on the later models of the Shilka involved the turret; the GM-575 chassis remained very similar.

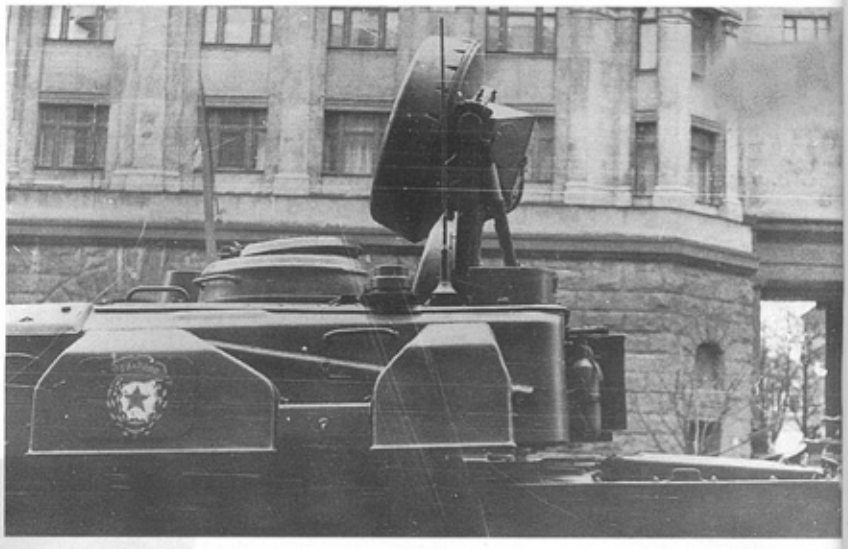
A rear view of the ZSU-23-4V at the Artillery Museum in St. Petersburg.



A rear view of the turret of a ZSU-23-4V. The panel at the center rear of the turret is for access to vehicle electronics, not for the crew. The bracket near the edge of the turret roof is used as a brace when the radar is folded for travel.

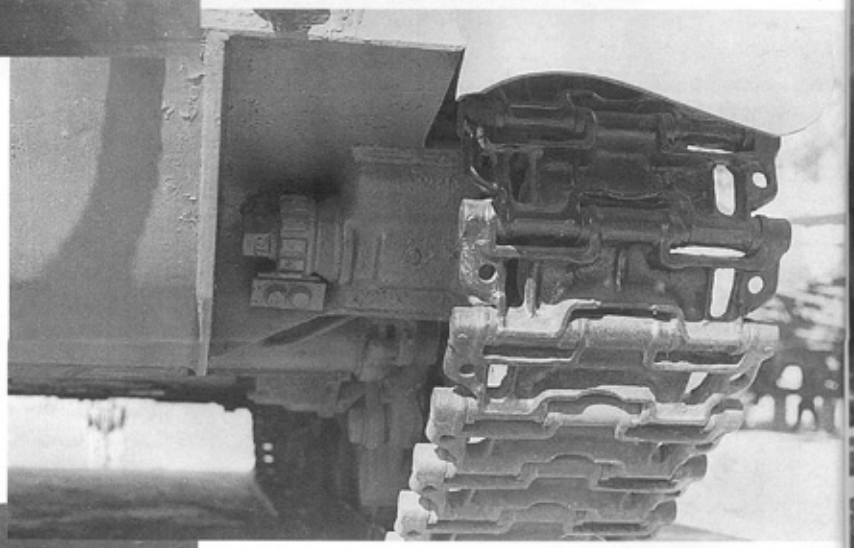
A right side rear view of the ZSU-23-4V Shilka on parade in Moscow in 1968 during its debut.

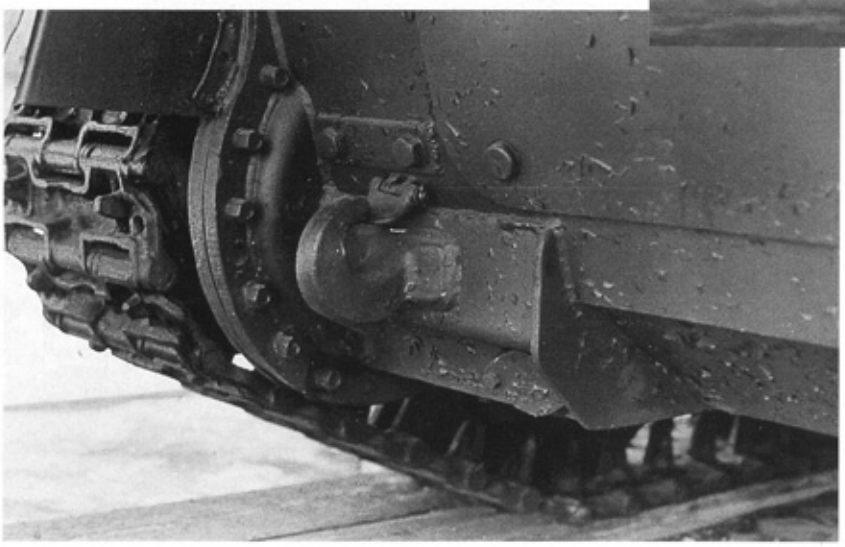
A side view of the ZSU-23-4V Shilka showing the cooling vent covers distinctive to this model of the Shilka.



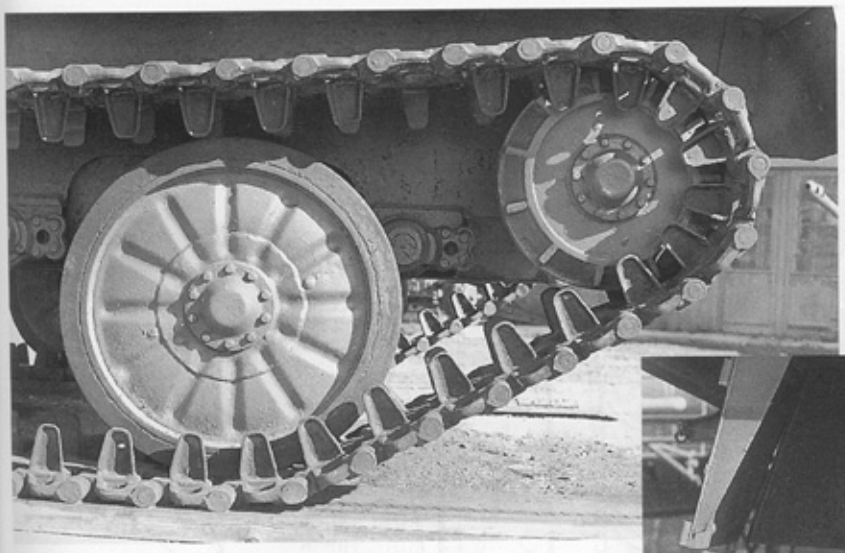
The RPK-2 Gun Dish radar has a dielectric cover mounted over the dish to give it better weather protection. This cover on the front of the antenna is usually medium grey, not the overall dark olive green color of the basic vehicle.

A detail close-up of the wheel mounting for the forward idler wheel at the front of the GM-575 hull.

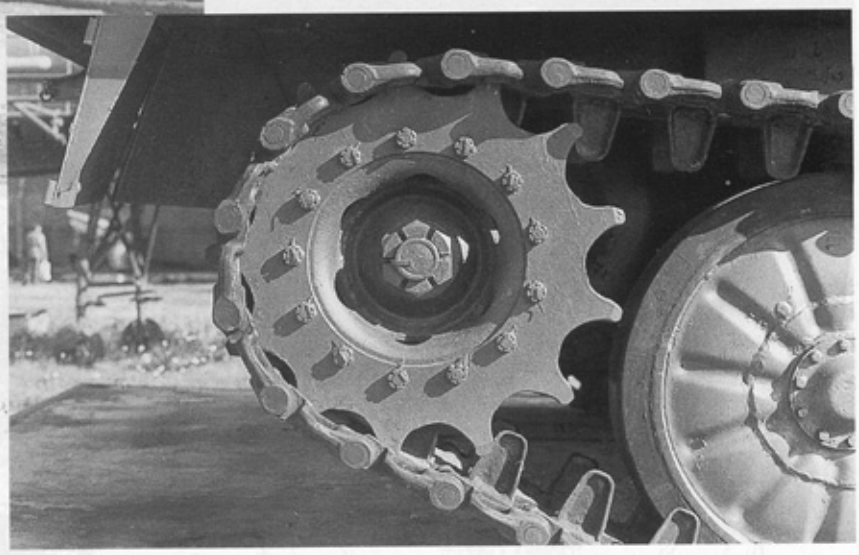




A detail close-up of the rear hull showing the towing hook.



A close-up of the forward running gear showing the idler wheel, the lead road-wheel and the torsion bar attachment detail.



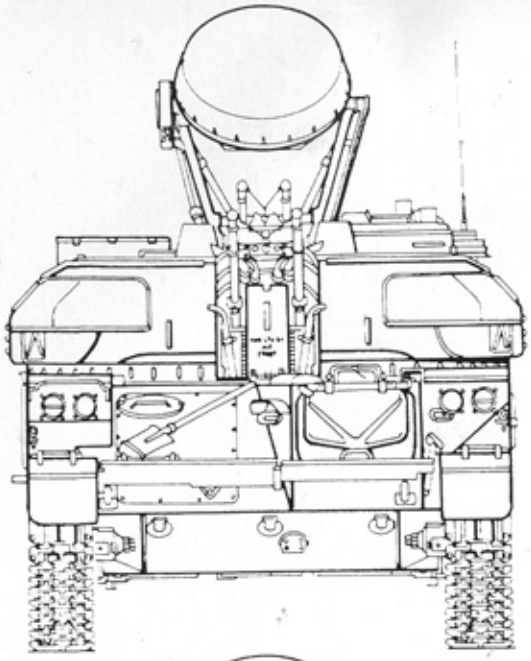
A detail view of the drive sprocket of the GM-575 hull. This vehicle shares the same road-wheel as the PT-76, ASU-85 and the SA-6 Gainful vehicles.

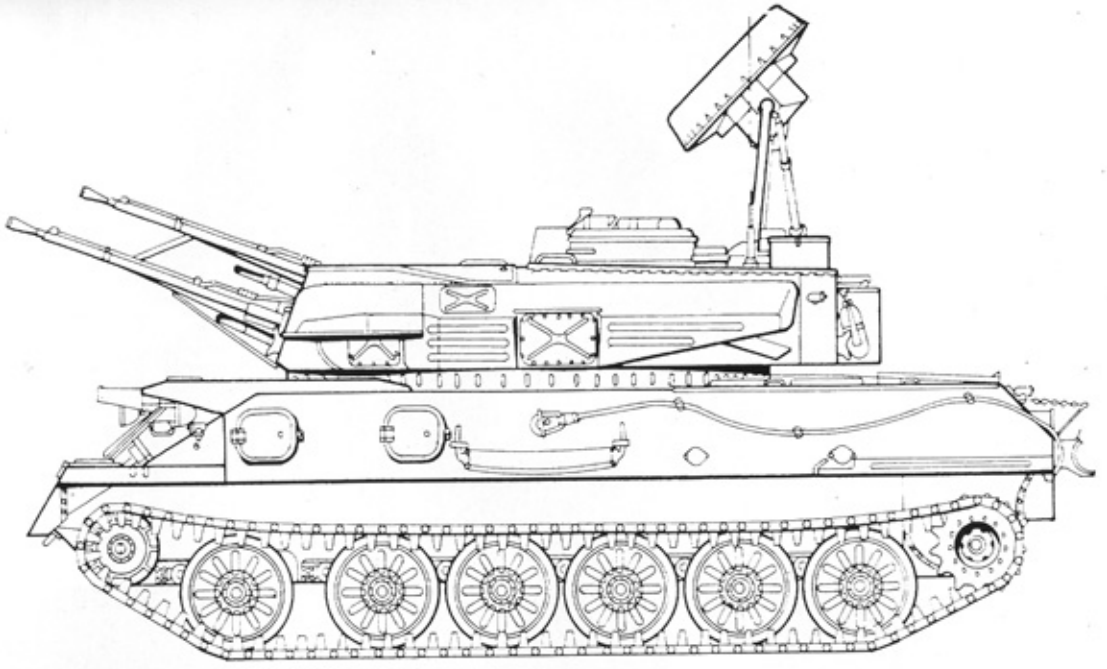
In 1972, a heavily reconfigured version of the Shilka appeared, the ZSU-23-4V1 Model 1972. This became the standard production version of the Shilka for almost a decade, and the most widely exported version. The most obvious change on this version was the extensive turret venting cover alterations.

A right side view of the new ZSU-23-4V1 Model 1972. This version deleted the stowage box at the front of the turret, and added enlarged bins on either turret side.

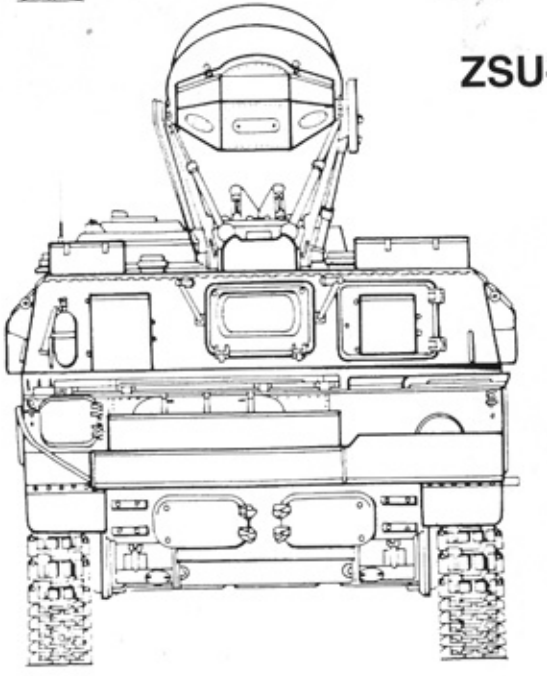
A ZSU-23-4V1 on road-march during a snow storm. This rear view shows that the rear hull configuration remained very similar compared to earlier Shilka models.

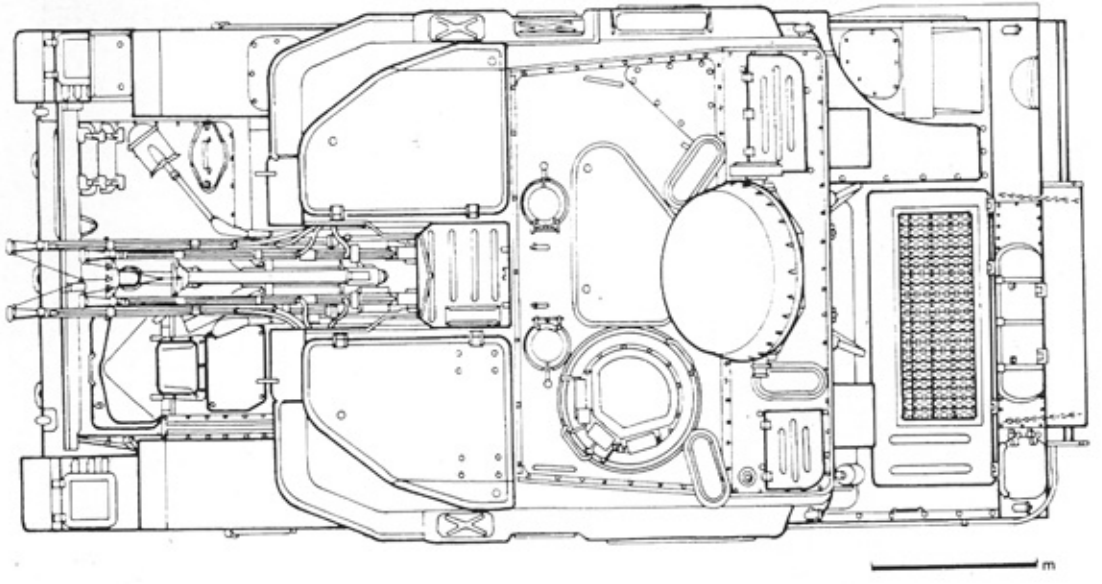
One of the hull changes on the ZSU-23-4V1 was the configuration of the door on the front of the right hull side. This is a ZSU-23-4V1 of the East German NVA.





ZSU-23-4V1 Model 1972





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A platoon of ZSU-23-4V1 of the East German NVA in a staging area in East Berlin prior to one of the annual parades.

The ZSU-23-4V1 had several small changes on the left hull side, including the addition of a second access port and a stowage bracket for a saw.

A pair of East German NVA ZSU-23-4V1 on parade in Berlin.

An East German NVA ZSU-23-4V1 in Berlin.

A pair of East German ZSU-23-4V1 Shilkas on exercise. In standard Warsaw Pact units, each tank or motor rifle division had an air defense battery with four Shilkas and four 9P31M Strela-1 (SA-9 Gaskin) missile vehicles.

A Hungarian ZSU-23-4V1 platoon on march following a Warsaw Pact exercise. This view clearly shows the distinctive bulges of the reconfigured turret on this version.

A Polish LWP ZSU-23-4V1 on exercise in the 1980s. The *szachownica* (checkerboard) national insignia is followed by a tactical number.

A classic view of the ZSU-23-4V1 Shilka at work. Two Shilkas provide air defense cover as a T-55 tank unit pass by.

A platoon of ZSU-23-4V1 Shilka on exercise in the Soviet Union in the 1980s.

A snow-camouflaged ZSU-23-4V1 crosses a pontoon bridge during winter maneuvers in the USSR in the 1970s.

The Shilka established its fearsome reputation after its use by Egyptian air defense units in the 1973 war with Israel. The Shilka was widely credited a being the single most important weapon in blunting the effectiveness of Israeli ground attack aircraft. The Egyptian vehicles were camouflaged in an overa pale sand color with airbrushed bands of pale brown and grey.

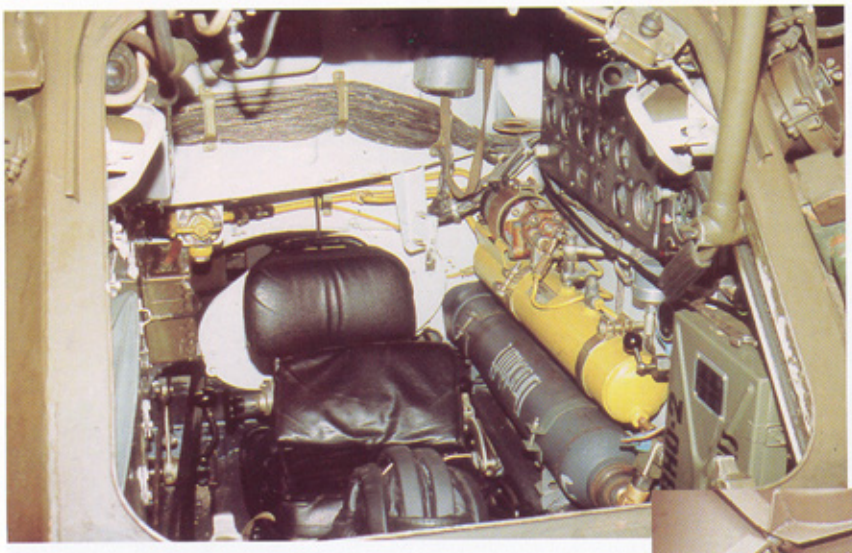
The Afghan Army received a small number of ZSU-23-4V Shilkas in the late 1970s, seen here on parade in Kabul.

Another view of the Afghan ZSU-23-4V1 Shilkas. These vehicles were used several years later in the war with the mujihadeen forces.

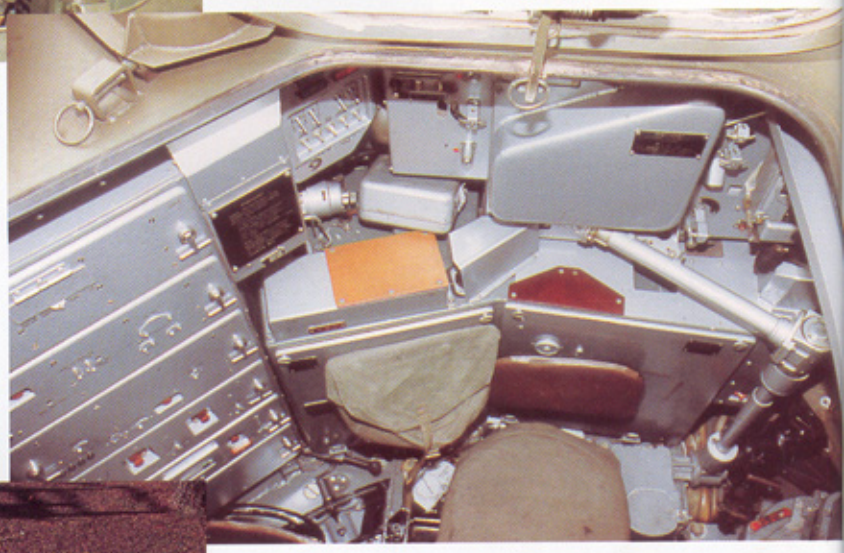
A ZSU-57-2 of the Finnish Army with a T-72M1 in the background.

A frontal view of the ZSU-23-4V. The GM-575 chassis is a close relative of the GM-578 chassis used with the 3M9 Kub (SA-6 Gainful) air defense missile vehicle.

A ZSU-23-4M of the former German NVA. In this view, the radar antenna is pointed backwards. (Michael Jerchel)

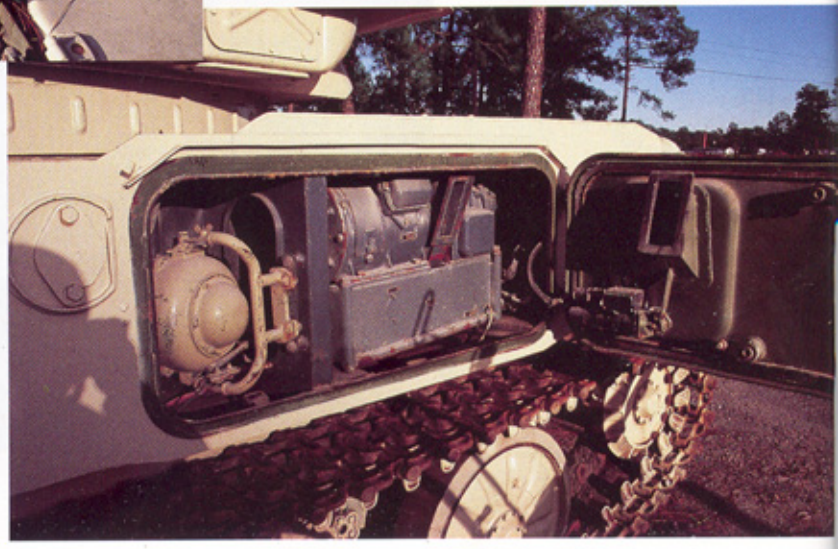


A view inside a ZSU-23-4M, in this case a former German NVA vehicle in pristine condition. (Michael Jerchel)



A view inside the main turret hatch looking towards the rear, which shows the electronics modules behind the gunner's station.(Michael Jerchel)

The roof of an Iraqi ZSU-23-4M showing the covers of both optical gunsight periscopes in the open position.



A view of the right side access door opened up showing the transformer for the vehicle electrical power supply, as well as the stowage location for the OU-3GA2 infrared searchlight for the commander's cupola.

A ZSU-23-4M of the Iraqi 96th AAA Regt. 8th Infantry Division, knocked out in Kuwait by US Marine units during Operation Desert Storm in February 1991. (US Marine Corps)

An Iraqi ZSU-23-4M Shilka knocked out by US Marine units in Kuwait during Operation Desert Storm. The discoloration of the rear hull is due to an intense engine compartment fire. (US Marine Corps)

A rear view of a ZSU-23-4M of the Lebanese Special Forces, captured from the Palestinians. The special forces insignia is pasted on the rear left stowage box. (Yves Debay)

An overhead view of the turret of a ZSU-23-4M of the Lebanese Special Forces Brigade, captured from the Palestinians. The brigade insignia is carried on the turret front. The crew wears American pattern CVC's, supplied via Israel. (Yves Debay)

A side view of a ZSU-23-4M of the Lebanese Special Forces, captured from the Palestinians. In this view, the radar antenna is folded down in the travel position. (Yves Debay)

A front view of a ZSU-23-4M of the the Lebanese Special Forces Brigade, captured from the Palestinians. In this view, it can be seen that the barrel covers are off. (Yves Debay)

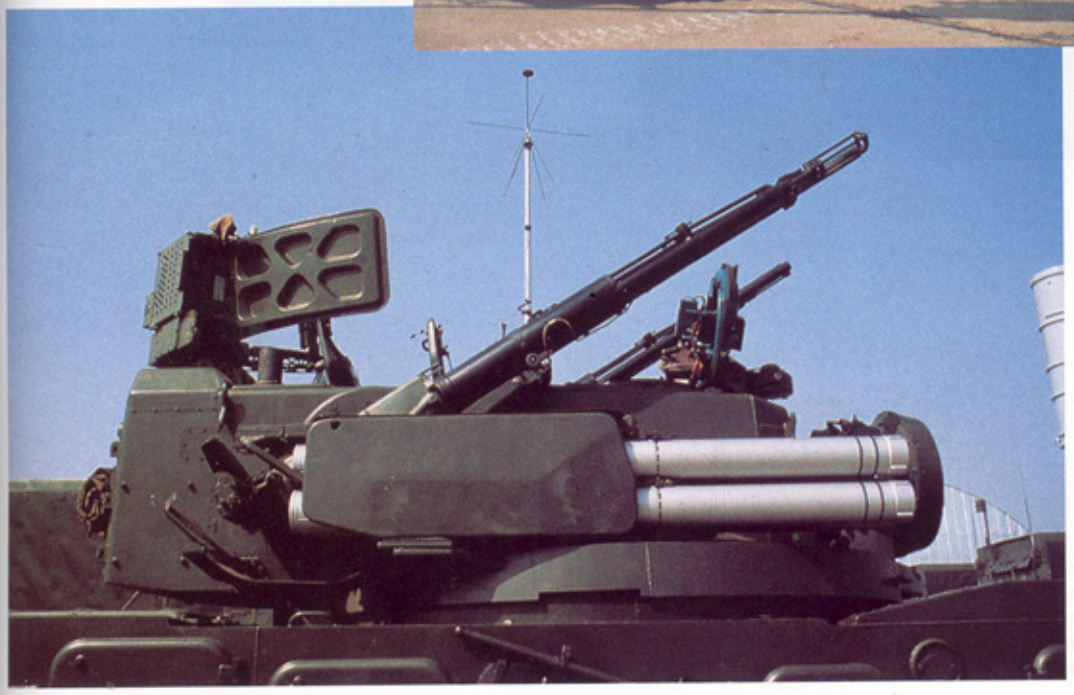
A head-on view of a ZSU-23-4M of the Lebanese Special Forces, captured from the Palestinians. The brigade insignia is evident on the left side of the turret superstructure. These vehicles are popular due to their tremendous firepower. (Yves Debay)

This 2S6 Tunguska-M self-propelled anti-aircraft gun/surface-to-air missile system is firing with its twin 2A38M 30mm guns. (Vyacheslav Aphonin)

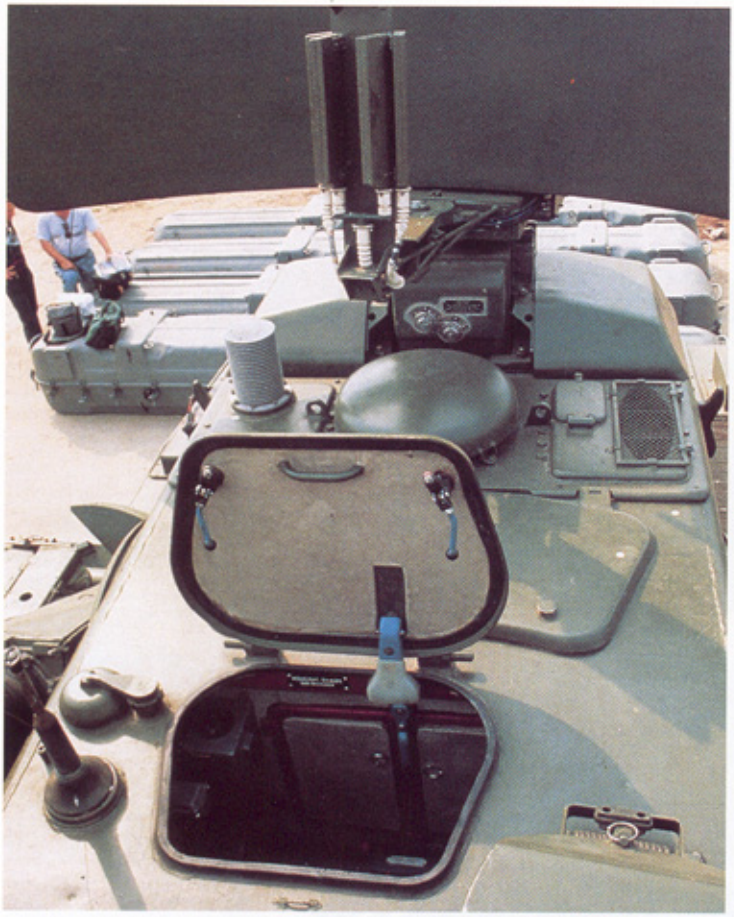
Loading the launcher of the 2S6 Tunguska-M self-propelled anti-aircraft gun/SAM system with 9M311 missile. (Vyacheslav Aphonin)

A rear view of the 2S6M system with the 1RL144M Hot Shot surveillance radar in the erected position.

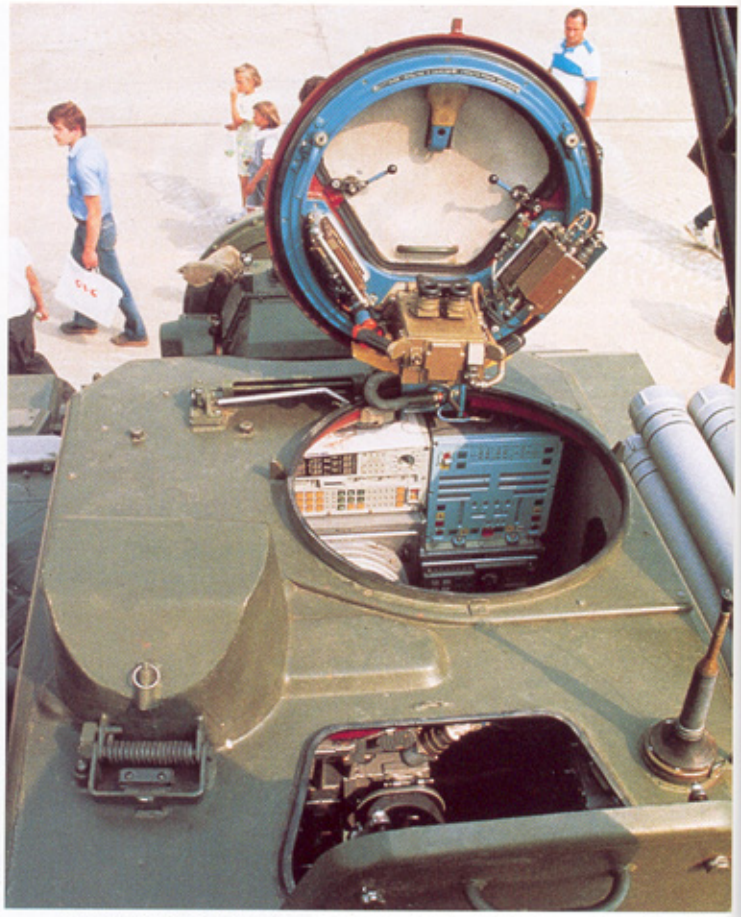
In this view, the Treugolnik missiles are in the elevated position along with the gun system.



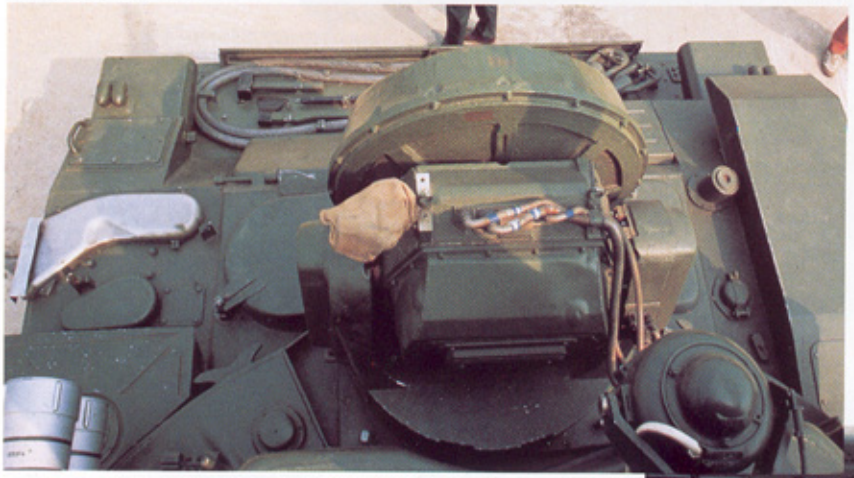
A detail view of the right turret side with the missiles stowed.



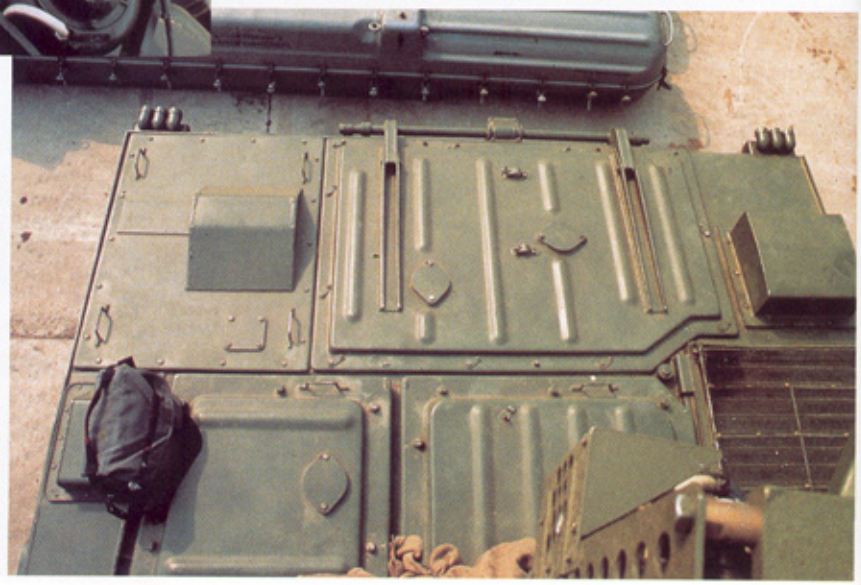
An overhead view of the turret roof looking aft. There is a three man turret crew in the 2S6M.



A detail view of the forward half of the 2S6M turret roof looking towards the commander's hatch.



A view looking down on the target tracking portion of the 1RL144 Hot Shot radar system at the front of the Tunguska-M turret.



An overall view of the Tunguska rear engine deck.

A good view of the standard stowage practice for the Shilka. The small panel at the rear of the hull is used to tie down a large canvas tarp that is draped over the vehicle to protect the expensive turret electronics when the vehicle is not in use.

One of the lesser known clients of the ZSU-23-4V1 Shilka was the Imperial Iranian Army, seen here on parade in Teheran in the late 1970s, followed by an artillery unit equipped with American M577 command vehicles and M109A1 self-propelled guns. The Shilkas were used extensively by both Iran and Iraq in the 1980's Gulf War.

An interesting overall view of a Syrian ZSU-23-4V1 Shilka captured from the Syrians by the Israeli Army in the 1973 war. The Syrian vehicles were painted overall Soviet olive green with small patches of pale sand and medium grey.

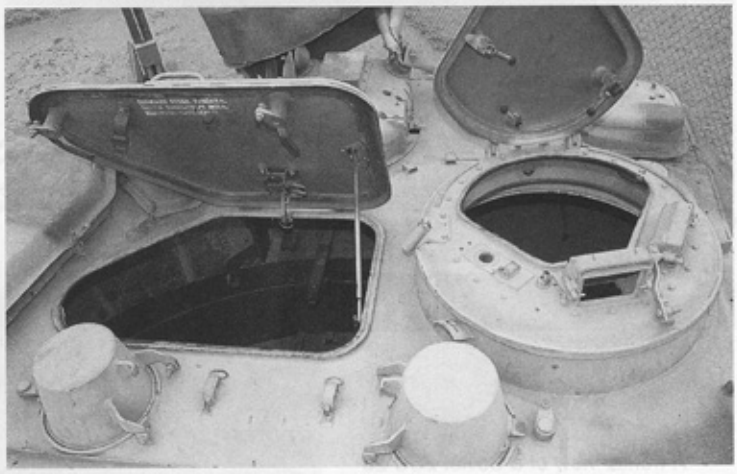
A Polish LWP ZSU-23-4V1 Shilka during the 1976 *Tarcza* wargames. Aside from the red and white national marking, the orange circle with black triangle is a standard Polish motorway sign to indicate a wide vehicle or other possible moving road hazard.

In the mid 1970s, the Shilka underwent its last major modernization as the ZSU-23-4M Biryuza. By then, the name Shilka had become almost synonomous with air defense gun vehicles, and the new name, *Biryuza*, never stuck. This view from the right side shows the large filter on the turret roof which is one of the distinguishing features of this model.

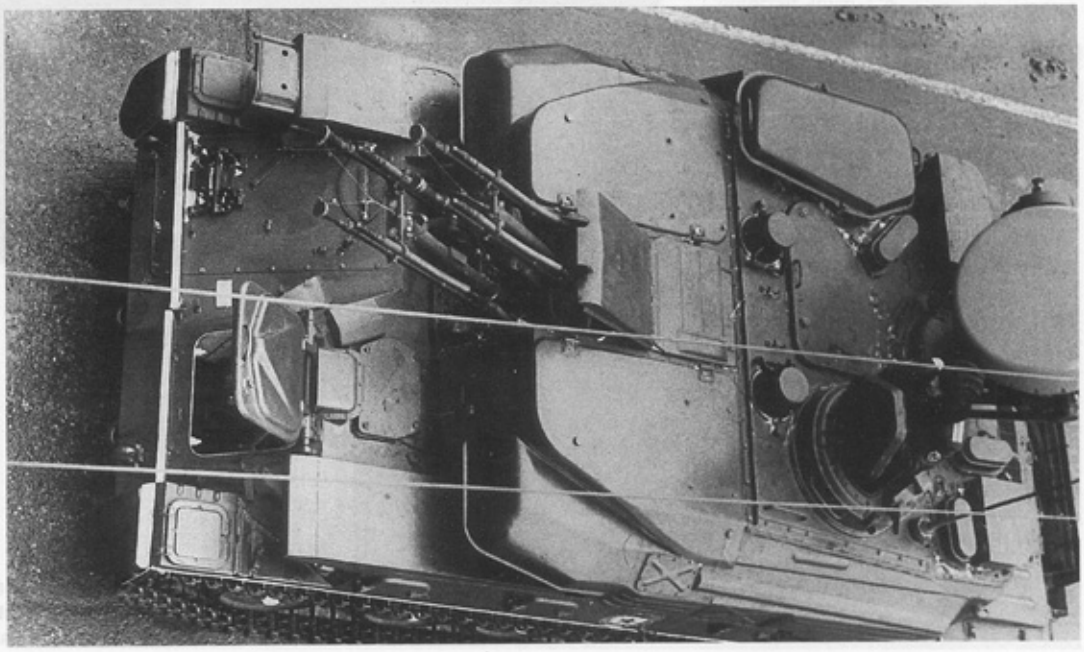
A side view of the ZSU-23-4M during its debut in Moscow in 1977. Other changes on this model included the new cover over the gun assembly and changes in the shape of the turret bulges.

A frontal view of a ZSU-23-4M. The parade paint trim helps to illustrate another change on the - M version, the reinforcing ribs on the bow of the vehicle hull.

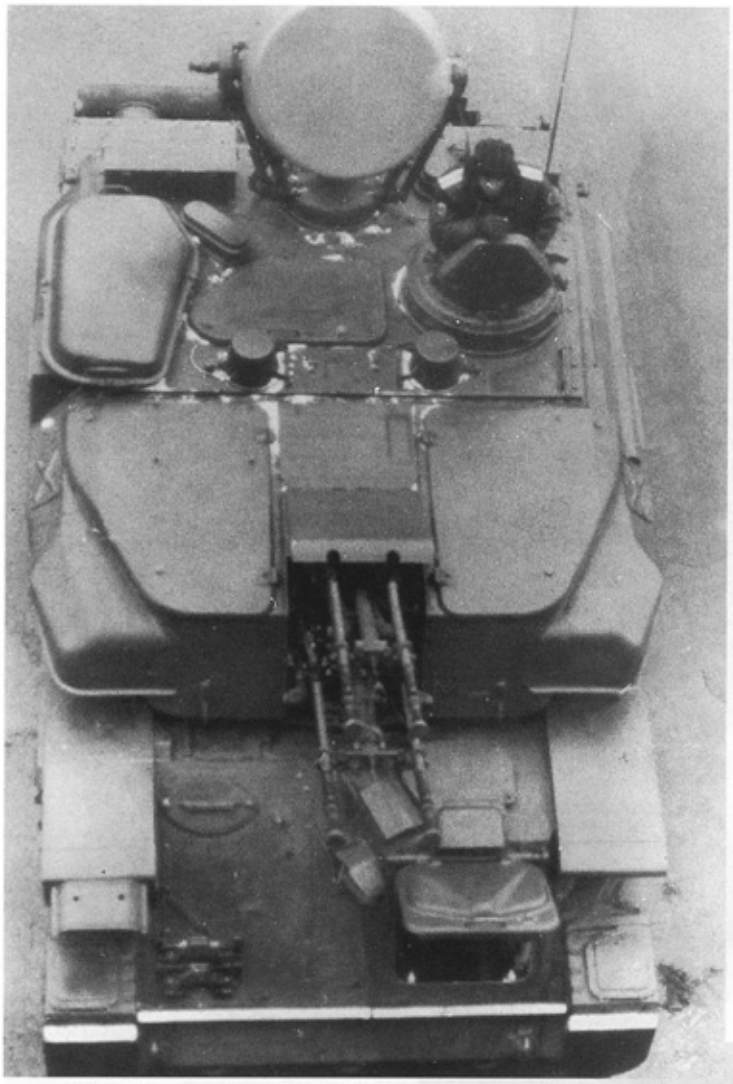
A left side view of the ZSU-23-4M showing the changes on this side. Notice that a third access port has been added to the hull side, the saw bracket has been moved aft and there is a reinforcing rib on the top rear of the side turret pannier.



A roof detail view of a ZSU-23-4M currently preserved at the OPFORs facility at the US Army National Training Center, Ft. Irwin, CA. The circular cupola on the right side of the turret is for the vehicle commander, the other hatch is for the gunner and rangefinder.



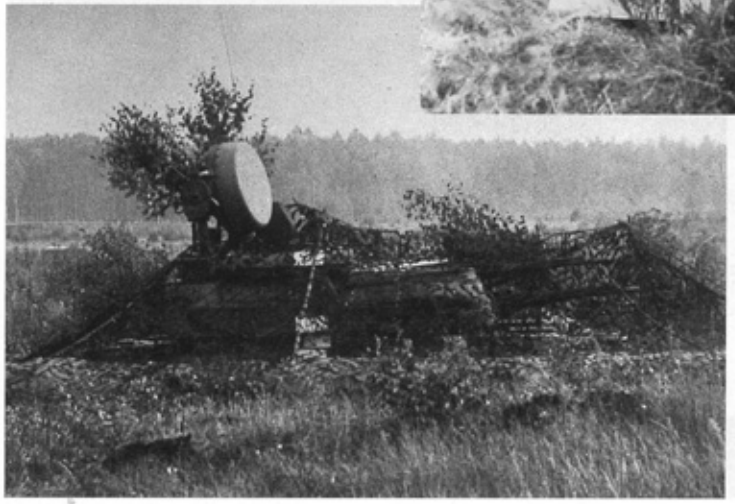
An overhead view of a ZSU-23-4M. This view shows several of the changes on this model including the large air filter cover on the left turret roof opposite the commander's cupola, the added cover over the gun assembly and the reinforcing rib on the right side pannier.



Another overhead view of the ZSU-23-4M. This view gives a good sense of the shape of the panniers on either side of the turret.

A ZSU-23-4M in Algerian Army service in a scheme of medium sand over olive green.

A frontal view of a Soviet ZSU-23-4M on maneuvers in Czechoslovakia in 1989. This view highlights the fact that - M version does not have the folding panel under the gun assembly found on all earlier models of the Shilka.



A ZSU-23-4M on summer maneuvers showing the preferred tactical deployment - in an entrenchment with the vehicle covered by a camouflage net with only the RPK-2 radar dish showing.

A ZSU-23-4M during wargames in Czechoslovakia in 1989. In this view, the RPK-2 radar dish is folded down. The electronic box protruding upwards from the radar array is associated with the new IFF antenna carried on final production ZSU-23-4M vehicles. A non-standard jerry can is fastened to the turret rear, and the vehicle camouflage net is in the official stowage position att he rear of the hull.

A rear view of a ZSU-23-4M of the former German NVA. (Michael Jerchel)

A ZSU-23-4M at the OPFOR display, US Army National Training Center, Ft. Irwin, CA.

An Iraqi ZSU-23-4M currently preserved at the 24th Infantry Division Museum, Ft. Stewart, Georgia.

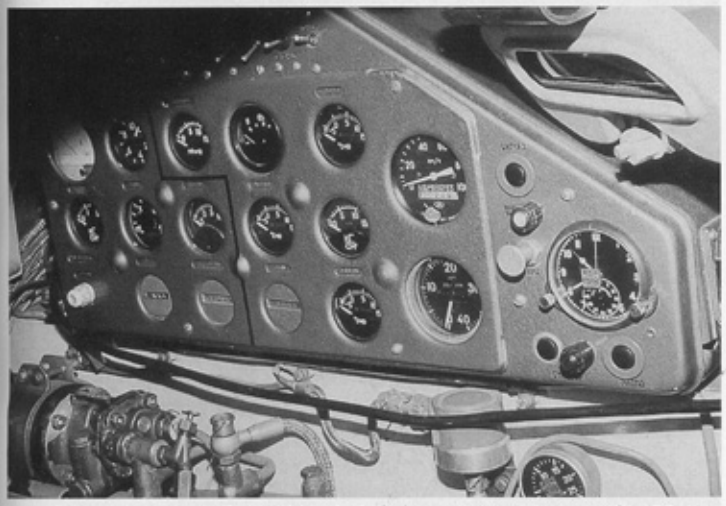
A rear view of an Iraqi ZSU-23-4M currently preserved at Ft. Stewart, GA.

The final modification of the ZSU-23-4-M took place in the mid-1980s with the addition of an improved *svoi-chuzoi* IFF (Identification Friend-or-Foe) system. This new IFF system led to the addition of two vertical antenna on the front of the RPK-2 Gun Dish radar antenna.

An interior view of the driver's compartment in a ZSU-23-4M, formerly of the Iraqi Army, now preserved at the 24th Infantry Division Museum at Ft. Stewart, Georgia. The view is a bit distorted due to the use of a 16mm fish-eye lens.

A view of the right side of the driver's compartment. The large opening to the right of the driver is usually covered by a metal panel.

A close-up shot of the driver's seat in a ZSU-23-4M showing the clutch. The box in the lower right of the picture contains the night vision equipment for the driver. (Michael Jerchel)

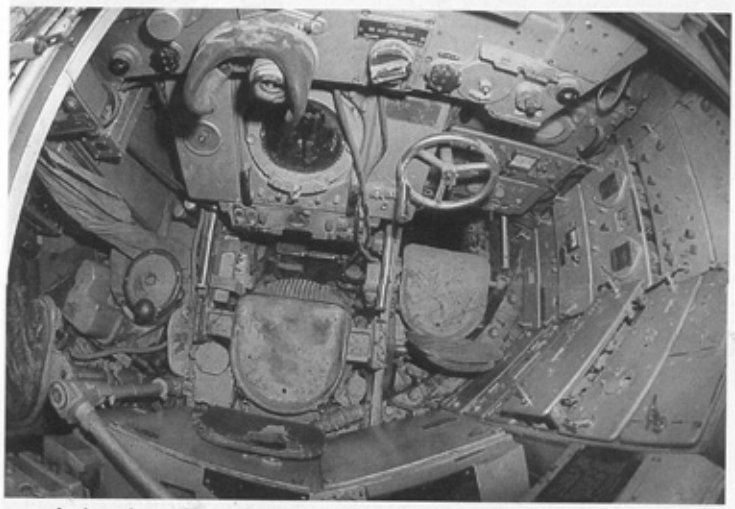


A close-up shot of the driver's instrument panel in the ZSU-23-4M. (Michael Jerchel)

A view of the left side of driver's compartment showing the main instrument panel. The Shilka is driven with brake levers as are found on tractors or older generation armored vehicles.

A view looking down into the commander's cupola in the left side of the turret. This view is looking in towards the rear of the commander's station. Among the electrical boxes to the commander's left is the R-123M vehicle radio, the T-46M1 module and the T-42M module immediately behind the seat.

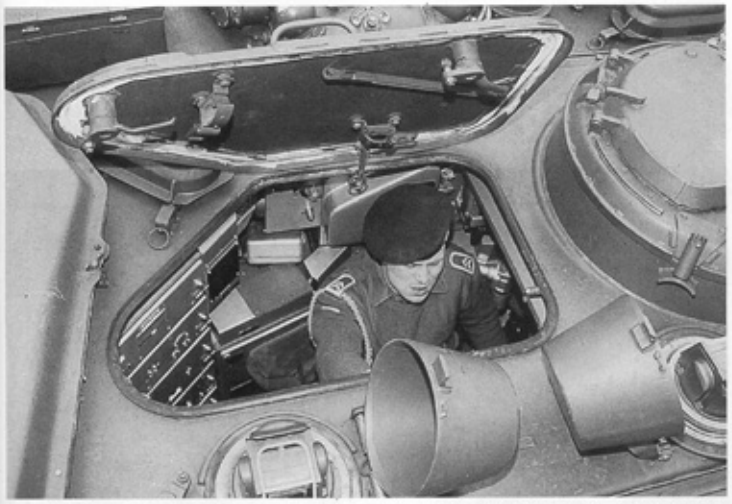
A view into the commander's station showing the B-1 instruments module in front of him.



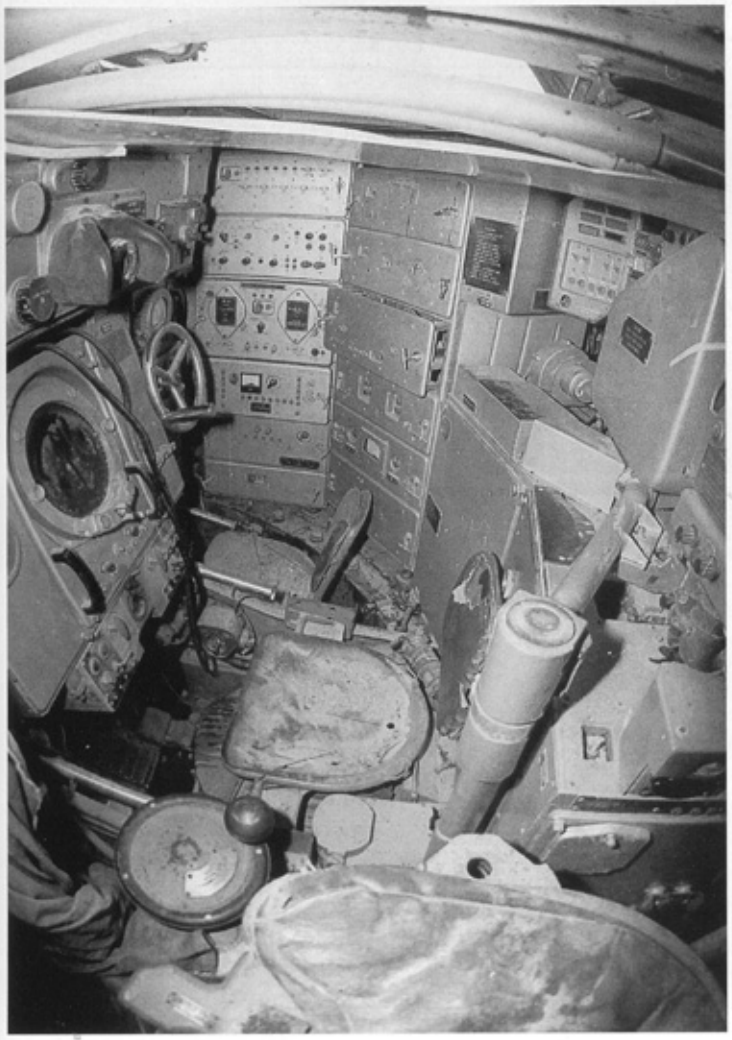
A view down the main hatch, looking into the main turret compartment. There are two crew in this portion of the turret, the gunner in the center and the range-finder to the right.

A view from the gunner's station looking leftward over to the commander's station. The commander's cupola can be seen at the top. The canvas seen at the front is part of a curtain that the commander can pull across to isolate himself from the other member's of the turret crew. This is done to prevent light from the commander's cupola from washing out the radar display at the gunner's station.

A view from the extreme right of the turret compartment with the gunner's station in the center and the commander's station beyond.

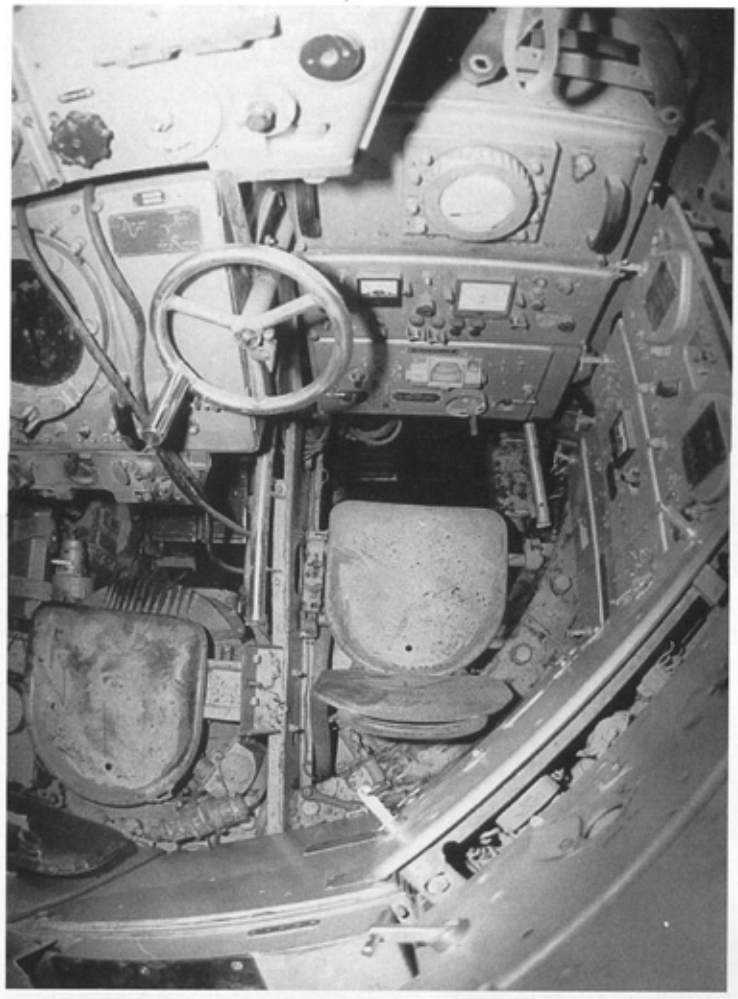


A view into the main turret hatch of the ZSU-23-4M, showing a Bundeswehr soldier in the gunner's seat. (Michael Jerchel)



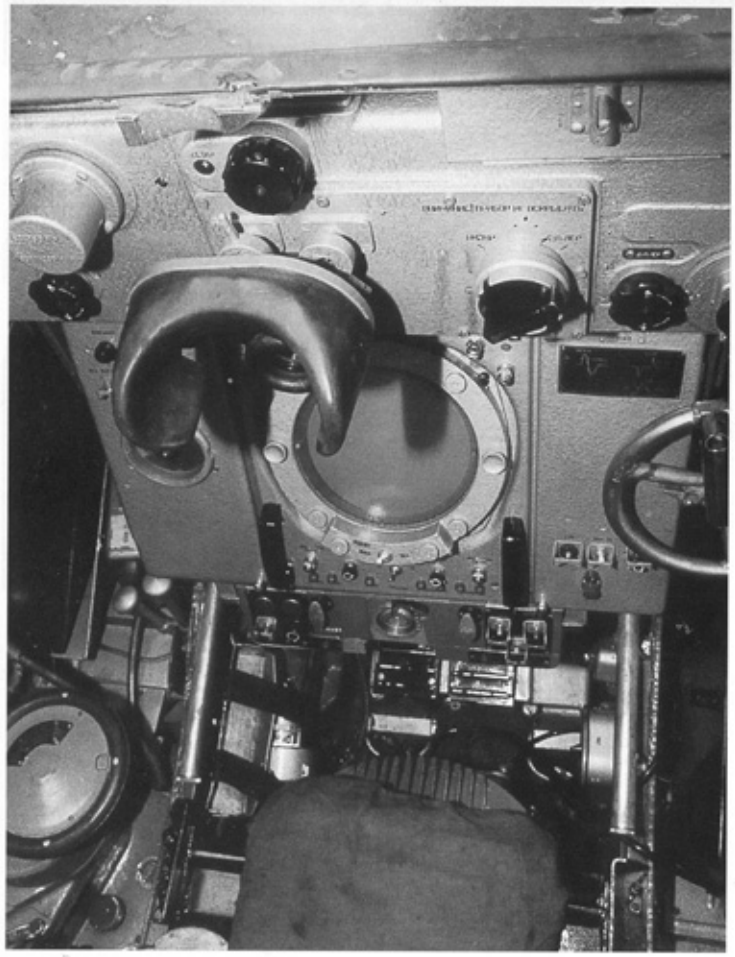
Another view into the main turret compartment, this time facing towards the rear showing the many electronic modules of the T-2M2 radar, T-44M1 and T-43M complexes behind the turret crew.

A view from the commander's station looking into the main turret compartment. The gunner's seat is in the center. The electronic cabinet in the far right side of the turret consists of the T-40M1 module in the front and the T-43M to the rear.



A view from above of the right side of the turret compartment where the rangefinder sits, with the T-37M1 complex immediately in front of him and the T-40M1 to the right.

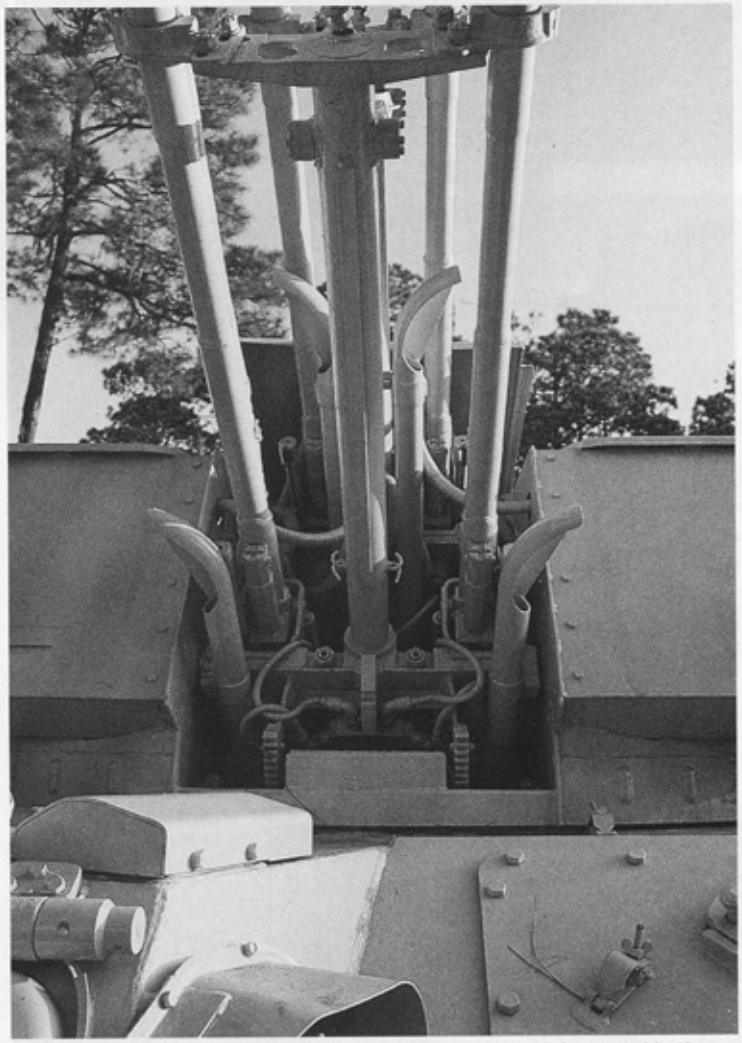
Another view of the gunner's station, this time looking slightly further to the left into the commander's station. This view shows the foot pedals for the gunner's turret traverse, as well as the manual back-up wheel. On this particular view, the gunner's control handles are missing; normally they would be found immediately below the radar screen.



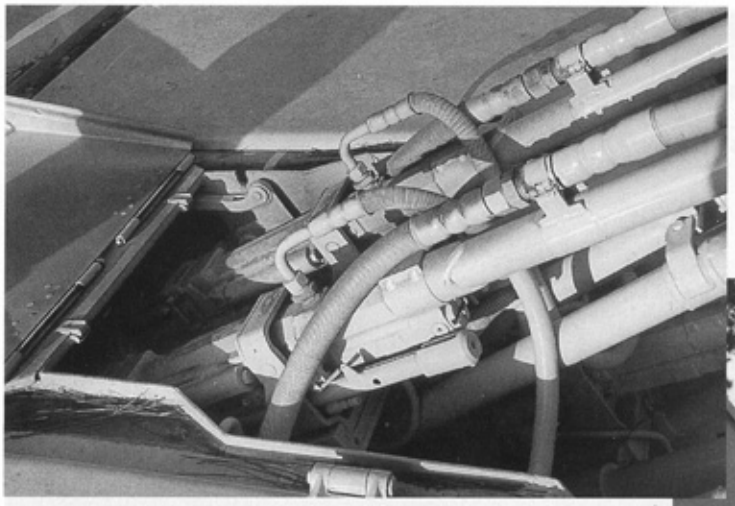
A view of the gunner's station giving a clearer view of his main instruments in the T-36M module: the display screen for the RPK-2 radar, and the optical sights in the B-7 module which are used as a backup. (Michael Jerchel)

A view of the boxes of the T-2M2 module behind the gunner's station which contain the electronics for the radar behind him.

A detail view of the driver's hatch on the ZSU-23-4M.

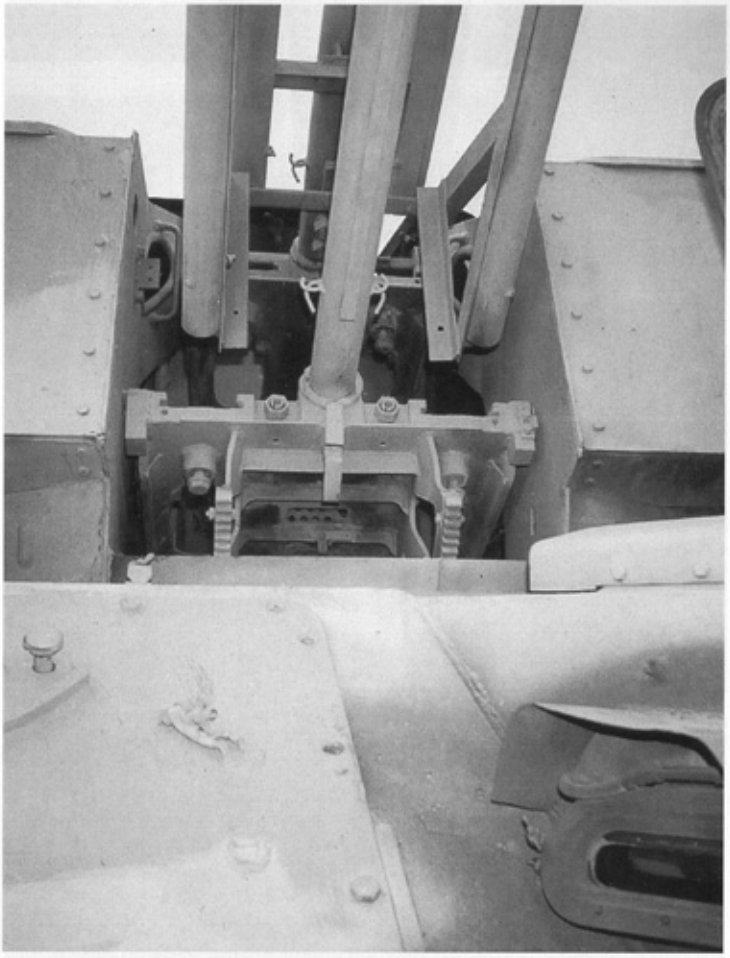


A detail view under the gun assembly on the ZSU-23-4M. If you compare these to views of the gun assemblies of the earlier models of the Shilka, you will notice that the large rectangular panel characteristic of the early Shilkas is not carried on the ZSU-23-4M.



A close-up of the gun assemblies near the turret roof. In this view, the new cover has been pushed back to get a better view of the hosing leading to the barrel cooling system.

A detail view of the gun barrels on the ZSU-23-4M. Notice that in this view, the gun barrel caps have been opened and the caps rest behind the muzzle brake.



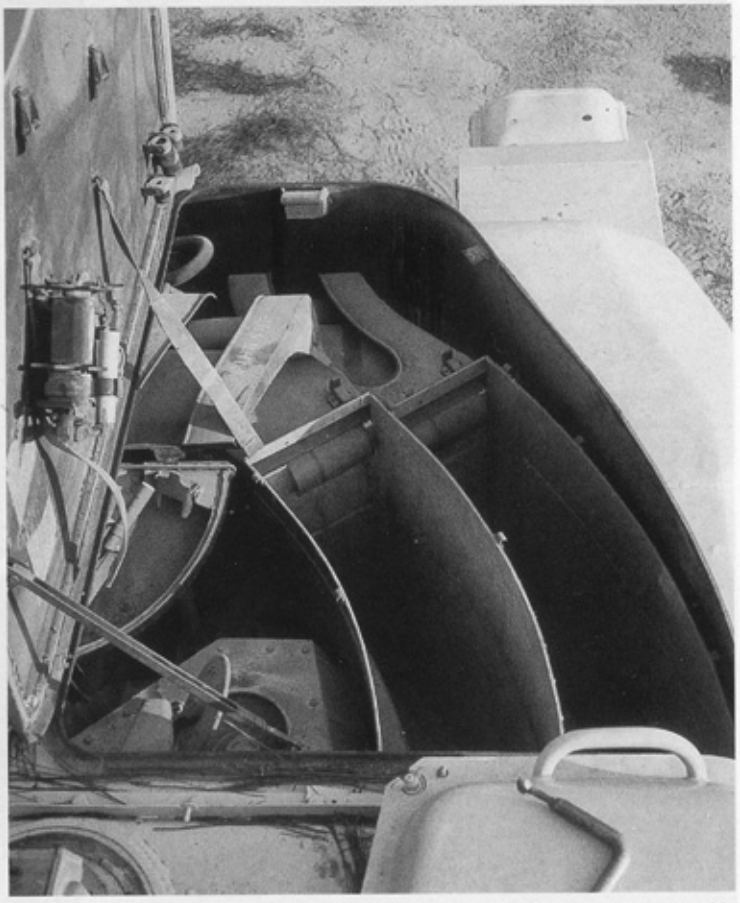
A detail view under the gun assembly of a ZSU-23-4M at NTC. This vehicle is missing its actual guns, and mock-ups have been added in their place, However this view does show the bottom cradle clearly.

Another view from overhead of the gun system and its many cooling lines. (Michael Jerchel)

A Bundeswehr soldier opening the ammunition compartment on a ZSU-23-4M. Note that in this view, the covers are installed over the ammunition feed trays. (Michael Jerchel)

A view into the central portion of the gun assembly on a ZSU-23-4M.

The crew of an East German NVA ZSU-23-4M loading 23mm ammunition into the main feed trays in the front of the turret.

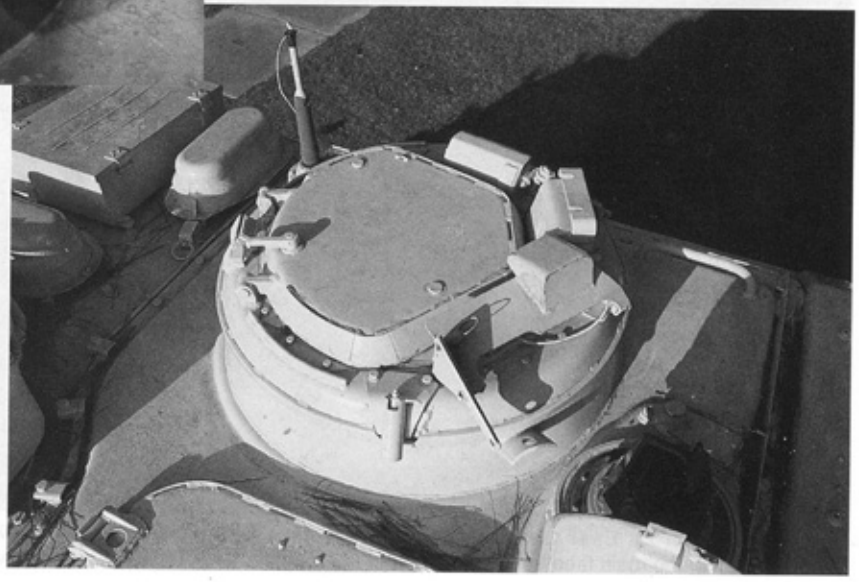


A view into an ex-Iraqi ZSU-23-4M showing the feed trays open with their covers missing.

A close-up view of the auxiliary optical gun sight on the roof of a ZSU-23-4M. (Michael Jerchel)

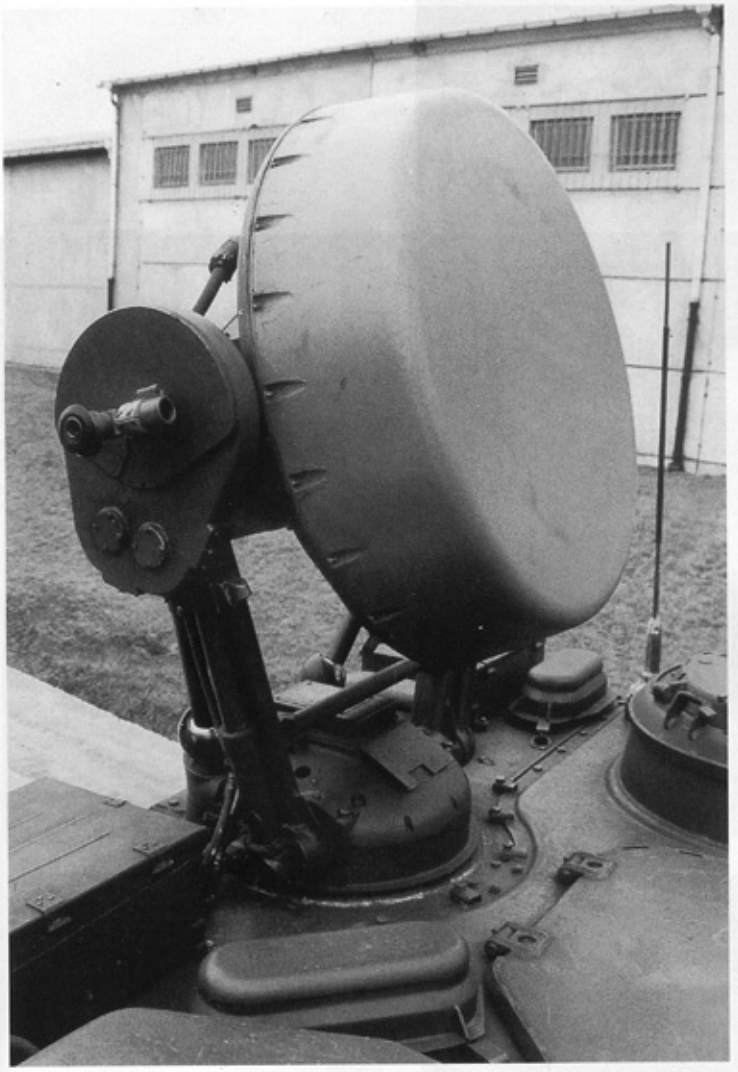
A close-up of the commander's cupola on a ZSU-23-4M with the auxiliary commander's sight installed. (Michael Jerchel)

A close-up view of the commander's cupola on the ZSU-23-4M showing how the commander can use his auxiliary optical sight to rough aim the main gun. (Michael Jerchel)

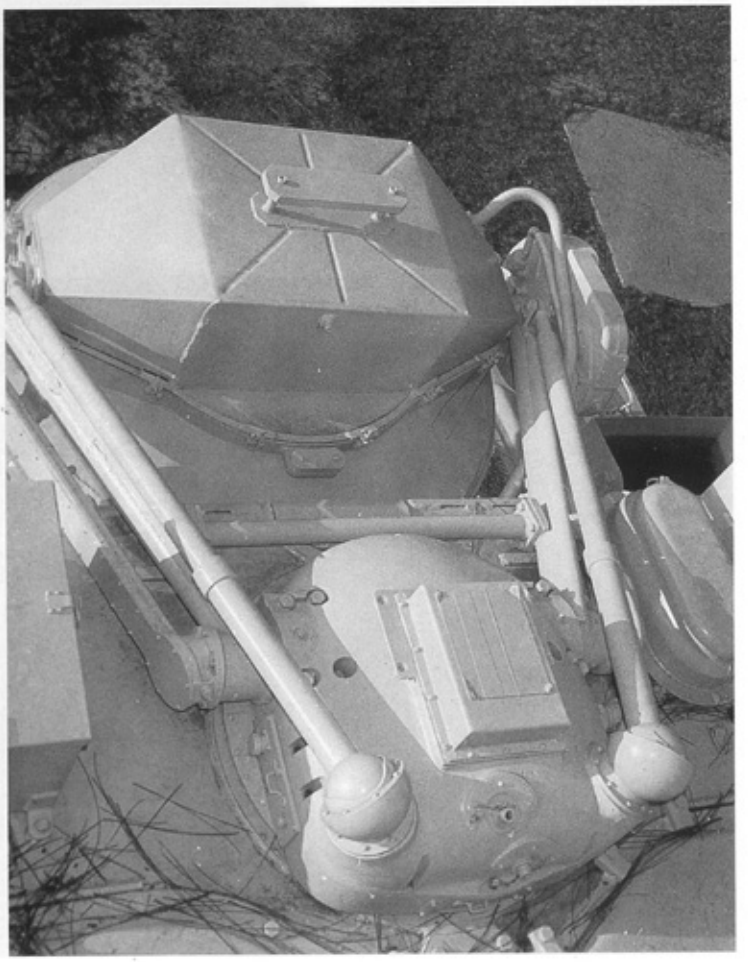


A close-up view of the commander's cupola of an Iraqi ZSU-23-4M.

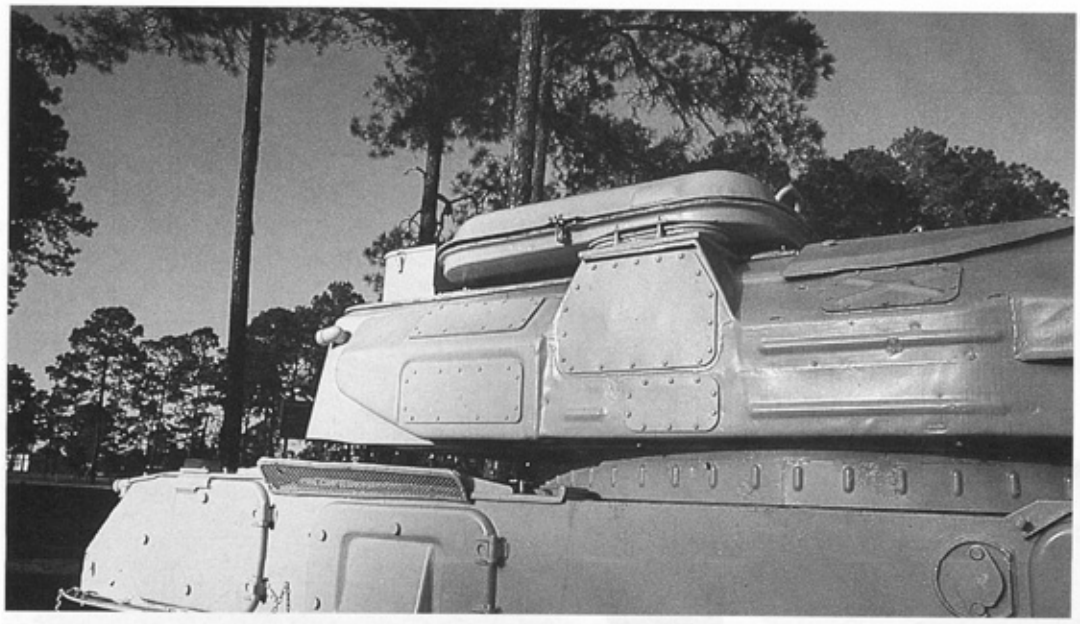
A detail view of the large air filter cover, one of the distinctive features of the ZSU-23-4M.



A detail view of the RPK-2 (Gun Dish) in operating position. The cover of the antenna is usually left in the original grey plastic color. (Michael Jerchel)

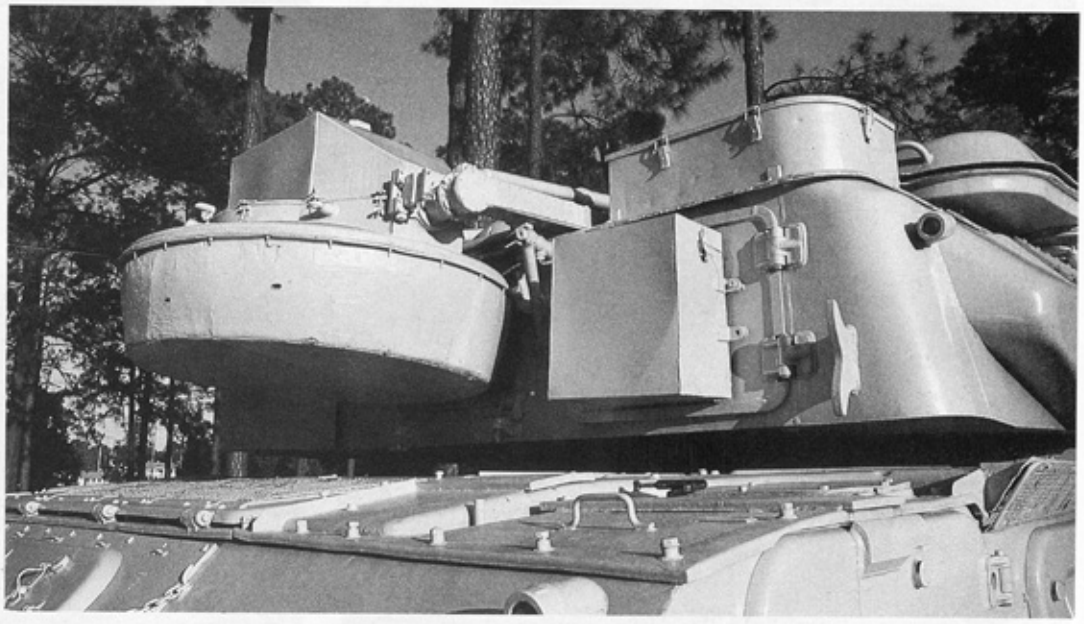


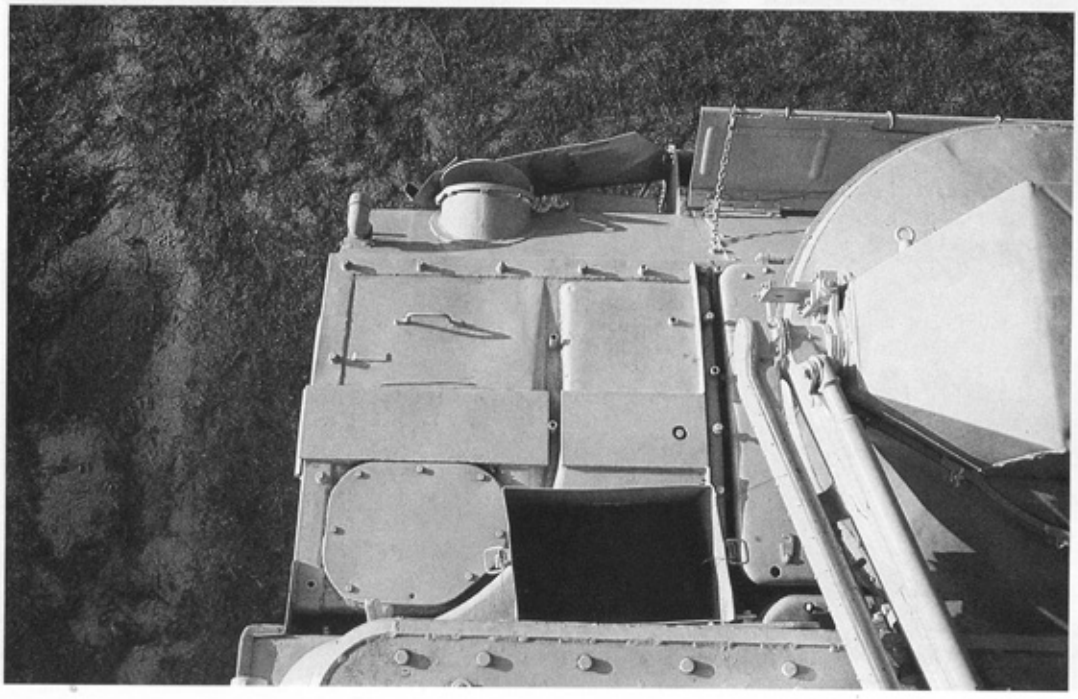
A detail view of the RPK-2 (Gun Dish) radar in the folded down travel position.



A detail shot of the right side of the turret of the ZSU-23-4M. The truncated pyramid compartment shape under the roof air filter is one of the distinctive features of this model of the ZSU-23-4M.

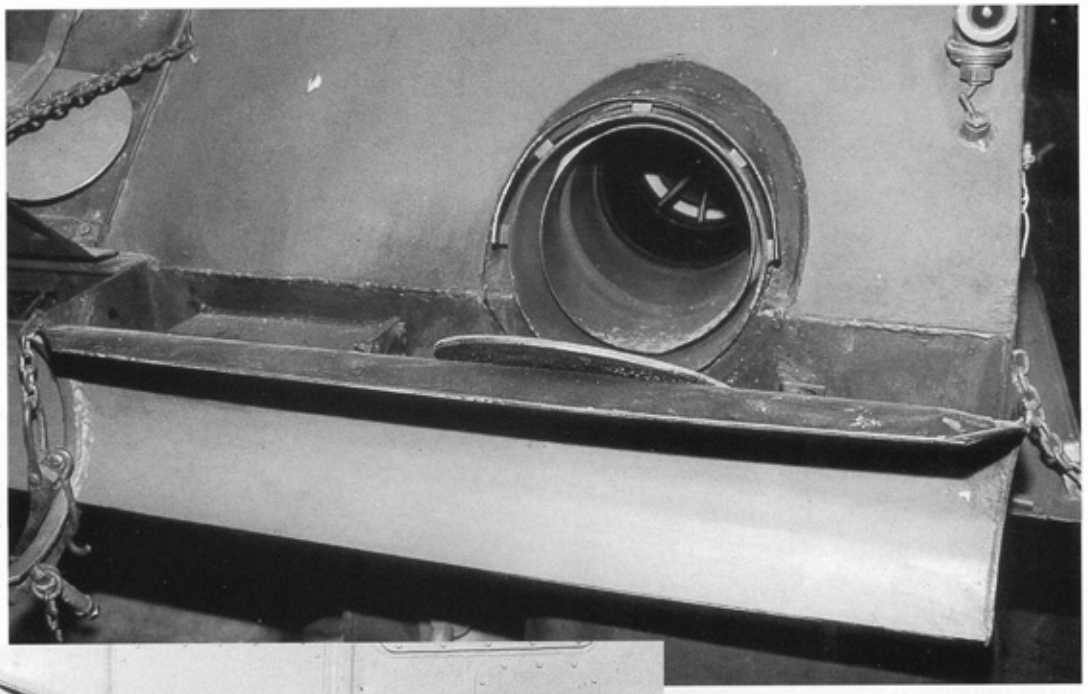
A detail view of the rear of the turret of the ZSU-23-4M showing the RPK-2 Gun Dish radar folded down.

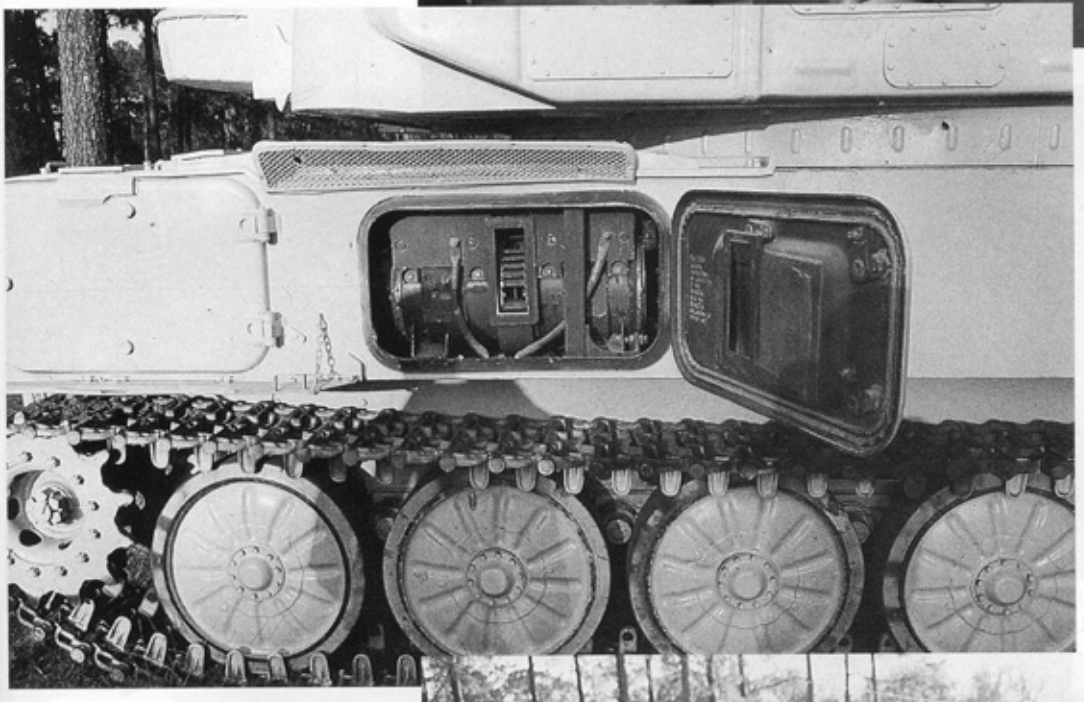




A view over the rear of the turret of the ZSU-23-4M looking down at the left side of the engine deck.

A detail view of the right rear area of the ZSU-23-4M hull showing the hatch for the auxiliary power unit in the open position. (Michael Jerchel)



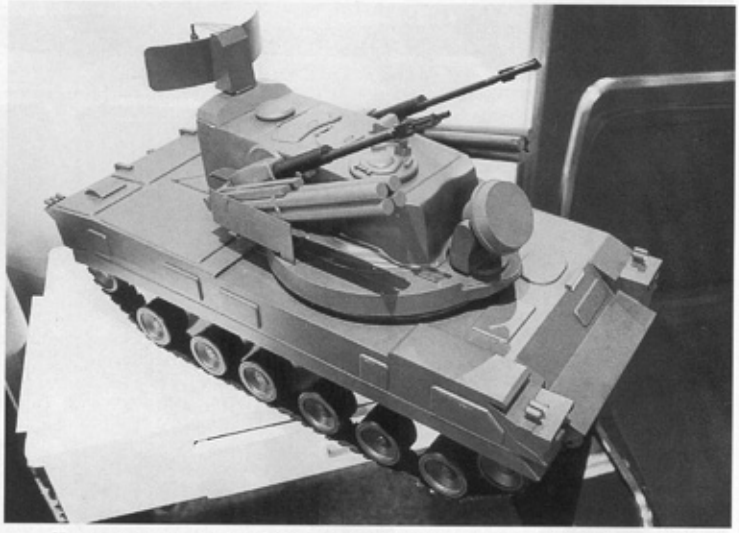


The second access panel on the right side opened up, showing the DG-4M1 80hp auxiliary gas turbine engine, used to power the vehicle electrical system when the main engine is turned off.

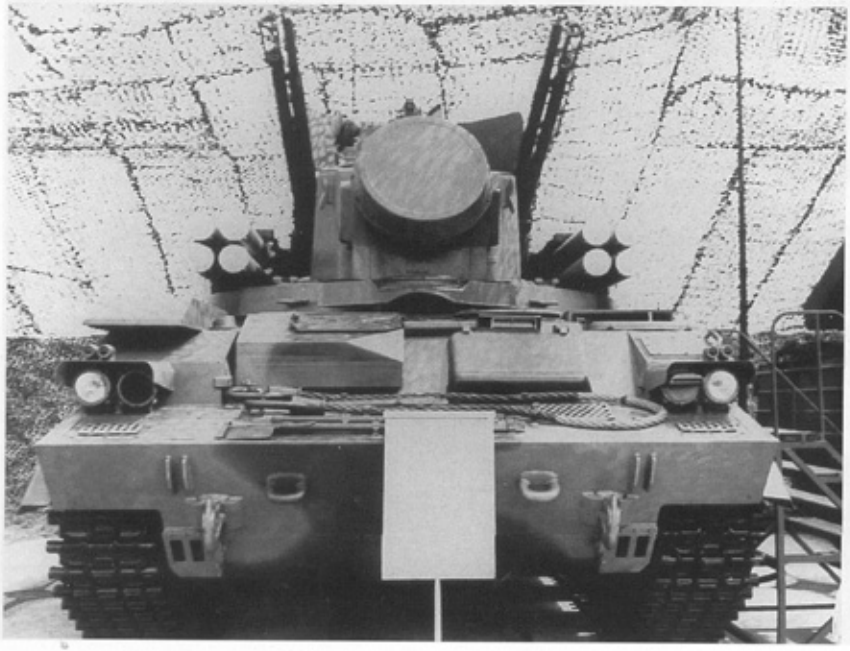
A view into the left side compartment. This compartment contains a small pistol-grip and cable which allows the turret to be traversed when the crew is not inside the vehicle.

While the BMP-2 is not usually thought of as an air defense vehicle, it has a secondary air defense role. The air defense platoon in each BMP-2 battalion has three BMP-2s. These carry three Igla (SA-16 Gimlet) portable air defense missile launchers. In addition, these vehicles sometimes carry additional 30mm ammunition and use their 30mm guns for anti-helicopter protection. This particular BMP-2 was taking part in 1990 Warsaw Pact exercises in Czechoslovakia and the white band marking indicates that it is part of the aggressor force.

Reports about a follow-on to the ZSU-23-4 Shilka began to emerge in the 1980s and the vehicle was called ZSU-X. This US Army interpretation suggested that it was based on the T-72 tank hull, a view that would change as more details emerged.



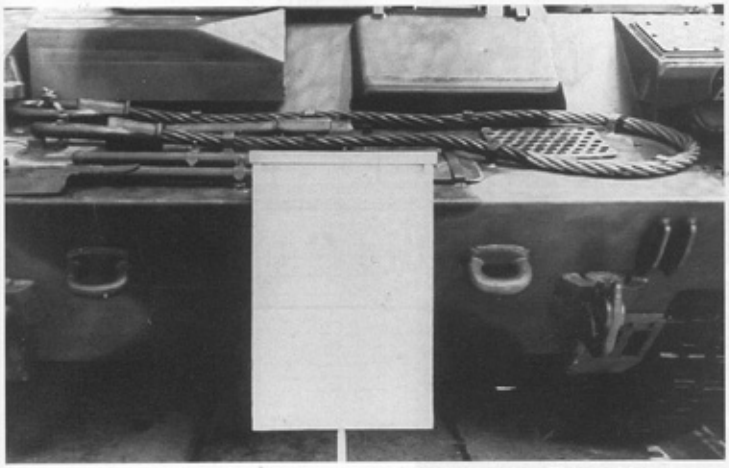
The follow-on to the Shilka is called the 2S6 Tunguska, named after the Tunguska river in Siberia. This Soviet model of the Tunguska shows the overall configuration of the vehicle.



The 2S6 Tunguska was first seen in detail in 1989 when Western observers were allowed to inspect a vehicle. In the front of the vehicle is the tracking radar, flanked on either side by the 30mm gun systems and the SA-19 missiles.

A right side view of the 2S6 Tunguska. The Tunguska is armed with up to eight 9M311 (SA-19) missiles, four on each side. Closer to the turret are two pairs of 30mm cannon, the outermost of each pair being fitted with a muzzle velocity reference system. On the roof of the vehicle is a separate surveillance radar, dubbed Hot Shot by Western intelligence. A small number of 2S6 Tunguska were supplied to the East German NVA, but they were withdrawn prior to the unification of Germany.

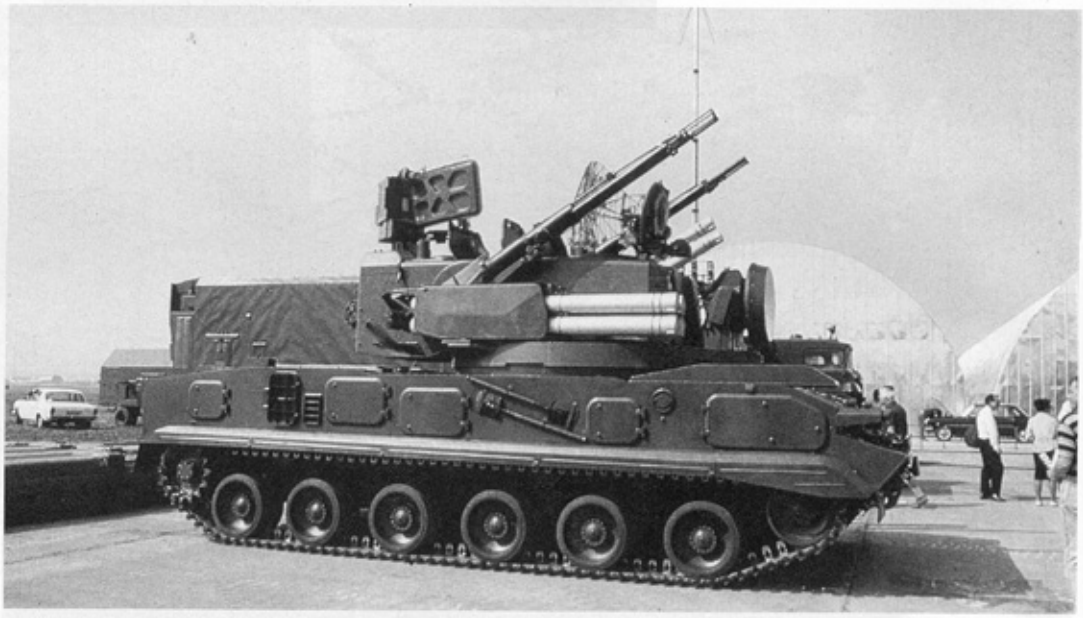
A left side view of the Tunguska. The Tunguska is based on a new medium armored transporter related to the MT-S, and also used on the Buk (SA-11 Gadfly), Tor (SA-15) and SA-17 air defense missile systems.



A close-up detail view of the bow of the Tunguska. This vehicle has a four-man crew with three in the turret and a driver in the left hull front.

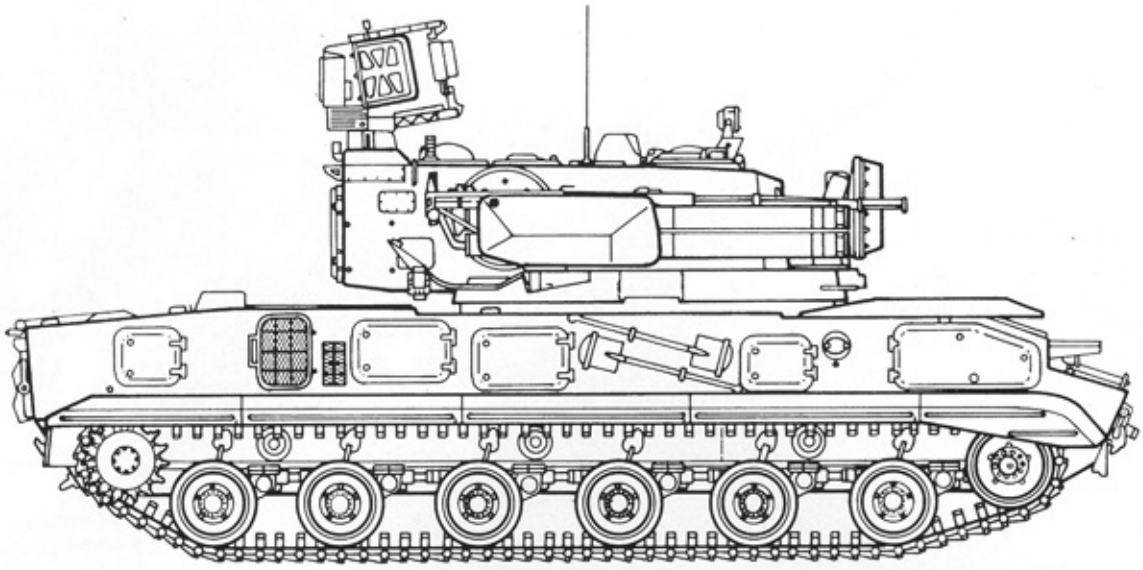
The gun armament of the 2S6 Tunguska consists of two closely located 30mm guns on either side of the turret. The outermost gun has a muzzle velocity reference system, used by the vehicle's computer to predict its ballistic path.

The improved 2S6M Tunguska-M is the current production version of this new vehicle. It can be distinguished from the earlier model mainly by small details, such as the switch to plain dish wheels instead of the spoked wheels traditionally found on the GM-100 series of tracked vehicles.

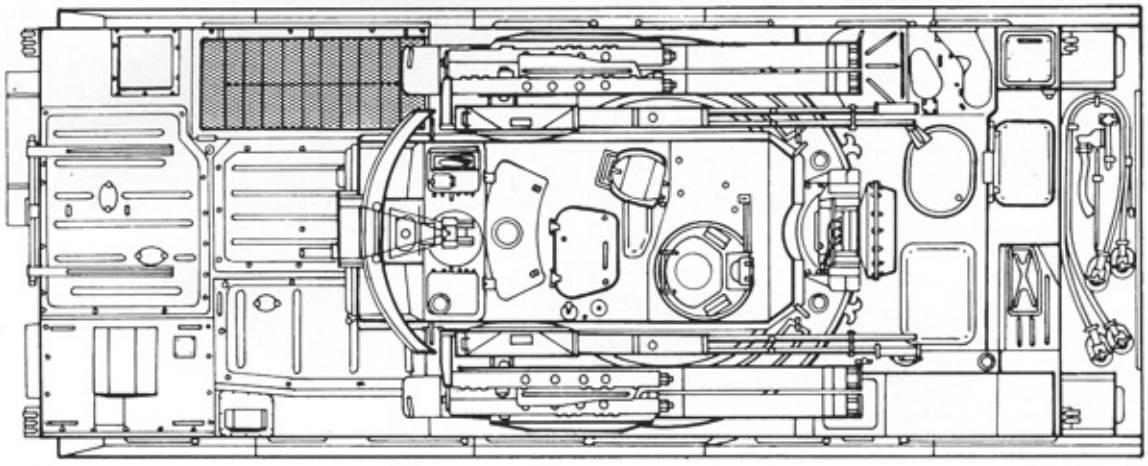


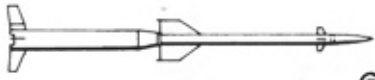
In this view, the 2A38M twin 30mm guns are in the elevated position *while the 9M311 Treugolnik (Triangle)* missiles are in the stowed position. The 2S6M vehicle has a hydraulic suspension which allows it to be lowered and locked down for firing, or elevated for road travel. In this view, it appears to be in one of the lower settings.

This close-up view of the left turret side shows that the missiles can be elevated in pairs of two.

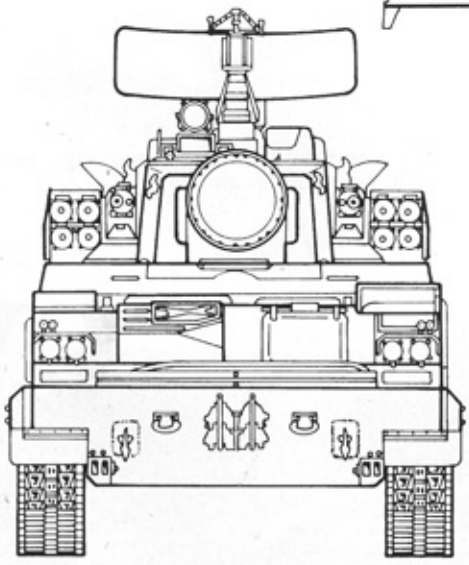


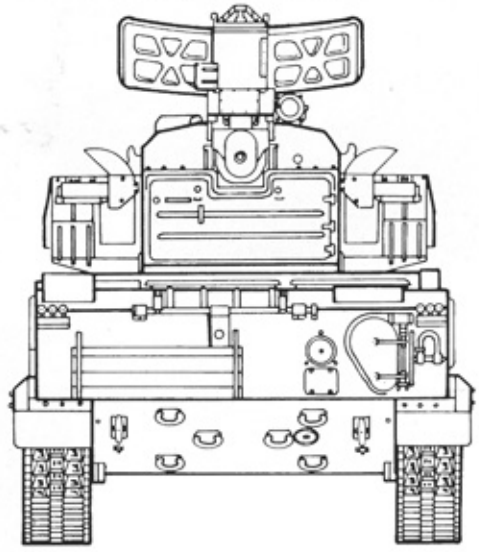
2S6M Tunguska~2C6M Тунгуска





9M311 (SA-19) Missile





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An overhead view of the 2S6M giving a better view of the engine deck area.

A view from the side of the Tunguska-M showing the engine deck and other details.

A rare view of a 2S6 actually in the field. This is a standard production type; the early production types deployed with the 23rd Guards Motor Rifle Division in the late 1980s had an earlier type of optical sight unit.

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ZSU-23-4

SHILKA & SOVIET AIR DEFENSE GUN VEHICLES

Steven J. Zaloga

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